May 1985 - April 1986

Illinois State Geological Survey Annual Report

Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION

ANNUAL REPORT
to the
BOARD OF NATURAL RESOURCES
AND CONSERVATION

May 1985 to April 1986

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1985 HIGHLIGHTS AND SUMMARY

MINERAL RESOURCES

- The estimated fuel and non-fuel mineral production for Illinois indicated an annual value of almost 3 billion dollars. This estimate includes coal ($1.76 billion), oil and gas ($844 million), and metals and industrial minerals ($348 million).

- A regional mineral assessment program, CUSMAP, covering southern Illinois south of Benton and Duquoin has been initiated with the USGS and the bordering states of Indiana, Kentucky and Missouri. This will be a 4-year cooperative effort to appraise the area for metallic and industrial minerals, coal, oil and gas, and groundwater resources.

- Three additional studies involving joint efforts with the USGS are already underway: (1) a Midcontinent Strategic and Critical Minerals Program to provide regional information useful in appraising mineral potential; (2) a pilot geochemical study of insoluble residue from cuttings and cores in selected Illinois wells to seek indicators of mineralized zones; and (3) a USGS and state-supported geological mapping effort (COGEOMAP) to develop detailed surface geologic maps in portions of southern Illinois.

- A multidisciplined Basin Analysis Task Force has been assembled to develop a sound regional framework of the Illinois Basin. Its purpose is to synthesize the vast amount of existing data on the basin and to stimulate economic growth and scientific progress.

Coal

- Our Mineral Resource Program is focusing on developing efficient low cost methods of removing sulfur from Illinois coals. To advance successful laboratory projects to a scale-up phase, a multidisciplinary engineering task group has been established. Projects showing the greatest promise include the ISGS aggregate flotation method for pre-combustion fine coal cleaning and a carbon monoxide/ethanol (catalytic) process for removing sulfur from coal supplemented by a new method for converting pyrite to a magnetic monoclinic form of pyrrhotite removable by magnetic separation techniques.

- The ISGS Aggregate Flotation method continues to give promising results indicating 80 to 90 percent of the heating value is retained while 80 to 90 percent of pyritic sulfur and ash-forming matter is rejected. The technique uses small bubbles, a foaming surfactant, a collector, and an agitator to float very fine coal away from ash and pyrite.

- A three-reaction pyrolitic desulfurization process has been developed that leaves only 0.05 to 0.20 percent of organic sulfur in the product. Three basic steps or reactions in this process include (1) reduction of pyrite and marcasite in coal by carbon monoxide to troilite; (2) conversion and removal of organic sulfur catalytically with ethanol over troilite; and (3) removal of spent iron sulfide catalyst, probably by magnetic separation.

- A new method was discovered that effectively converts pyrite in coal into a magnetic form of pyrrhotite. The controlling parameters for conversion are oxygen concentration and temperature. Bench-scale tests indicate considerable success in this conversion and in subsequent magnetic separation of the pyrrhotite.

- Other methods of removing sulfur from coal are being actively investigated including (1) an explosive shattering technique to develop very small particles, freeing more of the pyritic forms of sulfur; (2) low temperature charring; and (3) microbial removal of organic and inorganic sulfur.

- Efforts to map and evaluate coal resources in Illinois continued in southeastern Illinois in Saline, Gallatin, Hamilton, White, Edwards, Wabash, Wayne, Lawrence, and Richland Counties, and in west-central Illinois in Christian, Macoupin, Montgomery, and Sangamon Counties. The latter region contains an estimated 1.17 billion tons of coal with less than 2.5 percent sulfur--resources that have barely been touched by mining to date.

- Computerized coal databases continue to expand. Stratigraphic data from 2,700 mines, borings, and outcrops have been entered into the database on ENR's Prime computer. Also outlines of more than 5,000 surface and underground mines have been added to the GIS database. Merging of the various databases will permit rapid estimations of remaining resources and subsidence potential. Compositional data on coals have also been added to the computerized database.

- Studies of the deleterious elements in coal--sodium and chlorine--have indicated that chlorine is preferentially adsorbed on organic matter, especially the vitrain lithotype, while sodium is preferentially adsorbed on clay mineral surfaces. Optimal laboratory conditions have been approximated for leaching these elements from coal samples.

- Major improvements have been made in both the ISGS Coal Analysis Laboratory and the Thermal Analysis Laboratory for the chemical and thermal characterization of coal samples and for the automation of several research instruments. Fundamental chemical and engineering data have been obtained including pyrolysis rates of coal oxidation reactivities of coal chars, and softening and swelling properties of coals subjected to a variety of chemical and physical treatments.

Oil

- Although crude oil production in Illinois in 1985 rose by 4.8 percent to 30.3 million barrels, the number of wells drilled decreased dramatically (almost 20%) in response to threatening federal legislation and price decreases.

- Electron microphotographs and X-ray diffraction analyses of samples from seven Illinois reservoirs showed a variety of networking geometries of clay minerals and cementing materials in the pores of the reservoir rocks. The differences suggest the importance of designing completion practices and recovery methods tailored to the specific nature of the rock matrix in order to avoid formation damage, optimize producing rates, and increase the amount of oil recovery.

- An improved oil recovery initiative has been developed and a program begun to increase the recovery of hydrocarbon from wells and fields in Illinois. The initial phases have included research on reservoir characteristics of the Aux Vases sandstones, a core workshop for industry and scientists on the nature of Aux Vases and Ste. Genevieve reservoir rocks, and a start on a compilation of an atlas of oil fields in Illinois. Although more than 7 billion barrels of oil have been found in Illinois, only 3 billion barrels have been produced. Ways of increasing the recovery of the remainder is the major objective of this new effort.

- The exploration data base for hydrocarbons is being expanded to help reduce the risk in finding oil and to create incentives for industry to explore in Illinois. The effort includes model studies of Silurian reefs, the construction of a state-wide grid of lithologic cross-sections, documentation of Pennsylvanian oil occurrences, source rock studies to determine the nature and distribution of rocks that have sourced oil in the Illinois Basin, and crude-oil source rock correlation studies to better define oil migration processes and indicate possible new play concepts.

- The ISGS is compiling and editing a volume on Interior Cratonic Sag Basins as a part of an AAPG-sponsored Petroleum Basin Series. The Illinois Basin has been selected as a type example for the Sag Basin volume. Chapters on other sag basins, including the Williston Basin, the Michigan Basin, the Amazon and Parana Basins, the Paris Basin, the Baltic Basin, and the Gulf of Carpentaria in Australia are to be contributed to this volume by industry, other institutions, and individuals.

- Twenty-three gas and gas/oil wells were tested for flow rates this past year. As a result of ISGS testing and consultation, natural gas that would have been flared or shut-in is now being used.

- Further progress has been made in the computerization of oil and gas records and maps. Automated monthly drilling reports have been

introduced. Software is being evaluated for computer-generated structure contour and isopach maps.

Industrial Minerals and Metals

- A directory of Illinois stone and sand and gravel producers was issued in 1985.

- Attention is being directed to the possibility of locating new quarry sites and toward the development of underground mining to locate construction aggregate in the Chicago area where urban sprawl has encroached on existing quarry sites and threatens further expansion.

- Work is continuing on determining the expansion properties of Illinois aggregates construction proposed under freeze-thaw conditions. A statistical correlation has been noted between the amount of low-density chert and IDOT expansion data for gravel aggregates used in the construction of Illinois highways.

- Additional information is being developed on the mineral composition and pebble lithology of glacial materials in northern and south-central Illinois to permit resource evaluation of potentially useful deposits and provide information useful in land use planning.

- Various facets of clay mineral processing and production are being investigated to improve the utilization of Illinois clays. Additionally, the data base on clays is being put into a more readily retrievable form--a computerized file that will allow a more rapid response to queries from manufacturers who are seeking suitable sources for bricks, wall tile, flower pots, cement, cat litter, or similar products.

- Economic studies indicate that substantial tonnages of sand and kaolin can be economically recovered and produced from the fine rejects from St. Peter sandstone processing plants and from abandoned tailings ponds. Alternate process flow sheets have been designed for the recovery of fine sand and kaolin.

- Anomalous values of metallic elements have been recorded in insoluble residues from boreholes along a transect across the Illinois Basin. Follow-up efforts will be required to determine their significance for future mineral exploration.

- An expanded mineral resource appraisal program has been initiated in Illinois. (See introductory material under "Mineral Resources.")

- Analyses of the flourspar industry indicated that its decline strongly correlates with the decline in the steel and aluminum industries of the United States and was exacerbated by the low cost imports from Mexico, South Africa, China, and other countries. The revival of the fluorspar industry is dependent on finding higher

grade or larger volume ores to decrease unit labor costs and on improved economic conditions in the steel and aluminum industries.

- The geological data base for the state was further enhanced with the addition of 14,864 new logs, 562 sets of well sample cuttings representing more than 1,071,700 feet of drilling, and 104 sets of core. This data base is a valuable asset to the state, its industries, and its scientists. Its integrity must be ensured and protected.

ENVIRONMENTAL GEOLOGY

Siting for Economic Development

- Significant geotechnical information was provided to DENR and the Department of Commerce and Community Affairs and to Mitsubishi/-Chrysler on questions related to proposed sites in Illinois for the new Diamond-Star automobile plant. This information proved helpful in successfully siting the plant in Illinois.

- Major input has been made by the ISGS together with its sister Surveys and the State Museum to the state's proposal writer, IITRI, for locating the 4 to 6 billion dollar Superconducting Super Collider in Illinois. Previous information has been extended by the results of new drilling and new scientific observations to provide the sound documentation needed for tunnel design and for construction as well as for siting the SSC facilities to avoid fatal environmental flaws.

- The results of ISGS geotechnical studies for siting the SSC indicate that the region west of Fermilab has a stable, uniform, predictable geology. The bedrock is suitable for a tunneling project and has a low hydraulic conductivity; the tunneling characteristics are even more favorable than those of the successful Tunnel and Reservoir Plan (TARP) project in Chicago.

- Other SSC studies have dealt with natural radioactivity assessment in the siting area, the feasibility of using sand and gravel pits and quarries for disposal of the refuse from the tunneling for the project, and the impact of leachates from the refuse on surface and groundwater supplies.

- Two satellite image maps, one of the entire state of Illinois and the other covering the SSC site and surrounding areas in northeastern Illinois, have been issued as part of the siting effort for locating the SSC in Illinois. The public response to the state image map has been extremely positive and appreciative.

- The Geographic Information System (GIS) has been expanded to include data from a total of 81 strippable coal reserve maps plus other data sets during 1985, useful in siting industry and other facilities in Illinois.

- Geology for economic development and county planning is being carried out in Perry County to help coal mine operators, public officials, and interested citizens plan for long-term coal development in this highly productive coal area.

Waste Management

- An inventory of all known waste-disposal sites in Illinois has been prepared for the Hazardous Waste Research and Information Center.

- A three-year U.S. EPA-funded project was initiated to evaluate the performance of a field-scale compacted earthen liner.

- Monitoring programs are underway to evaluate groundwater and/or surface water contamination effects of sewage sludge applications in the Sanitary District of Rockford and in Rockton township, of coal wastes at a Turris Coal Company tailings pond, and of pesticides in Mason County.

- A mandated study of the regulations and regulatory practices for disposal wells used in the underground injection of industrial wastes in Illinois has shown them to be essentially effective in protecting underground sources of drinking water, human health, and the environment. Comparison of economic and environmental impacts of deep-well injection and a number of alternative disposal technologies has shown deep-well injection to be less expensive and to have, in many cases, a lower environmental impact than other systems.

- The adequacy of groundwater monitoring programs, a study mandated under the Currie Bill (HB3193), has shown that: (1) thorough hydrogeologic studies are necessary before adequate monitoring programs can be established; (2) individual site characteristics should be considered in the design of groundwater programs; (3) additional monitoring techniques (such as geophysical) should be used more often; (4) adequate record keeping is essential for determining changes in water quality; and (5) additional attention should be paid to on-site waste disposal and generators of hazardous waste. A dramatic improvement has been noted in the quantity and quality of groundwater monitoring at hazardous waste facilities in Illinois over the past 10 years.

- Investigations have shown that certain hazardous waste mixtures show a tendency to collapse clay minerals, creating avenues for leakage of hazardous wastes.

- At a hazardous waste facility near Wilsonville, Illinois, the migration of contaminants, some 100 to 1000 times faster than predicted, has been found to be due to the presence of joints formed by desiccation cracking in a polygonal pattern within the weathered zone of the upper part of the Vandalia Till.

- New studies involving waste management have been initiated, including: (1) the degree of risk of Class V injection wells on groundwater supplies; (2) assessment of risks from contaminated sediments in Waukegan Harbor; (3) laboratory studies to assess the factors controlling the extent and rate of biodegradation of organic chemicals by microorganisms; and (4) a study of the geochemical interactions of hazardous wastes with geological formations in deep-well systems.

- In a DNS sponsored project, the ISGS and ISWS have developed a comprehensive list of criteria to be used in siting a low-level radioactive waste disposal facility in Illinois in accordance with federal regulations and a compact between Kentucky and Illinois. Regional acquifer screening maps have been prepared.

- Reports, consultations, and responses were provided to numerous government agencies to aid in their processing of applications for the operation of disposal facilities, to advise on the testing and operations for deep well disposal, and in providing expert testimony on waste management.

Lakes and Rivers

- Potential impacts of record high levels of Lake Michigan have been called to the attention of state authorities, municipalities, industry, and owners of lake-front property. Counsel and advice have been provided on steps required to protect the shoreline and shore-facilities from erosional and storm damage.

- A Board-sponsored "Scoping Study for Lake Michigan Issues" revealed a number of areas for further research needed to preserve and protect Lake Michigan and its shoreline. A computerized bibliography of over 5,000 articles covering all research fields has been compiled in efforts commenced under Board funding and continued with Joyce Foundation support.

- Lake Michigan research has also produced updated maps of shoreline position; information on the distribution of ^{137}Cs in bottom sediments; depth to till, sand thickness, and depth to bedrock maps for Zion Beach Park and North Point Harbor; oblique aerial photographs used to monitor shoreline recession and property impacts; and radiocarbon dates for lake chronology.

- Newly funded projects on Lake Michigan provide for the preparation of a shore protection plan, revision of design standards for shore protection structures, and a study of the role of Silurian bedrock reefs exposed at the lake bottom on the lake trout fishing industry.

- Technical assistance was provided to a number of state and federal agencies and authorities, to municipalities, and to homeowners on improving shore protection.

- In the cooperative LTER program with the Natural History and Water Surveys, sediment textures and rates of deposition have been established for portions of the Mississippi River. The volume of Pool 19 is decreasing at a rate of 0.6 percent per year.

- The ISGS is participating in a project to determine the feasibility of constructing a riverine wetland within the floodplain of the Des Plaines River, Lake County.

- Geological and geotechnical information is being provided to save Heron Pond, a nature preserve, from destruction by the encroaching Cache River. Only 8 to 11 feet of alluvium overlies bedrock in the 40 to 70 foot space that separates the cypress-studded pond from the outer bend of a meander of the Cache River.

- Radiometric dating indicates sedimentation rates range from 0.7 to 3.6 centimeters per year at 13 locations in Illinois lakes.

Hydrogeology

- The extent of fresh groundwater resources is being determined in southwestern Illinois in Pennsylvanian aquifers and in the Mahomet Valley Region of east-central Illinois. In the latter area, in cooperation with the SWS and NHS, the ISGS is providing a geologic framework and defining aquifers capable of supplying water to a large-scale irrigation system.

- The communities of Aurora, Montgomery, Geneva, and Batavia are supporting a geological and geophysical investigation to locate new groundwater supplies in Kane County.

- The quality of water resources is being studied in two areas susceptible to contamination. In one study in Clay County, the effects of past and present oil production practices is being assessed. In another study in the Rockford area, aquifer continuity is being established for the design of a groundwater sampling program for water quality.

- The basic physical properties of thermal conductivity and diffusivity are being determined for Illinois soils to indicate where the best opportunities exist for installing geothermal heat pumps.

- The Groundwater Section was heavily involved during the year in providing letter reports on groundwater geologic conditions, in conducting electrical resistivity surveys, and in responding to telephone requests and consulting with visitors. Additionally, the ISGS is cooperating with the SWS in the development of a Groundwater Resources Assessment Plan, in evaluating the hydrogeologic setting of high-capacity wells in accordance with the Water Use Act, and in delineating trends to help municipalities locate and maintain quality water supplies.

Earth Hazards and Engineering Geology

- Landslides causing damage and hazardous road conditions were investigated near Watseka in Iroquois County and in and around Chester, Illinois, in Randolph County.

- A major program on mine subsidence, coordinated by the ISGS, has been initiated in cooperation with the U.S. Bureau of Mines. The program is designed to determine guidelines that will permit the maximum extraction of coal while minimizing the impact of mine subsidence on prime farmlands. The program is supported by federal and state funds (the latter through the Coal Development Board) acquired through the joint efforts of the Illinois Coal Association and the Illinois Farm Bureau. The work is being conducted by scientists at Southern Illinois University, the University of Illinois, and the ISGS. The Illinois Department of Mines and Minerals is also providing counsel and advice.

- During 1985, mine subsidence investigations evaluated the in-place strength of mine floors at two mines, assessed crop damage resulting from subsidence, and prepared for overburden studies at an active high-extraction mining site.

- Engineering geologists are reviewing the process for settling the boundary dispute between Kentucky and Illinois. They also aided in designing the Satellite Image Map of Illinois and the companion map on northeastern Illinois, in distributing products from the National Cartographic Information Center, in setting priorities for future cooperative mapping efforts by the USGS, and in handling numerous queries on maps covering portions or all of Illinois.

- The program of rock and soil mechanics continues to provide valuable research data, counsel, and advice for: (1) determining the tunneling characteristics for the SSC project; (2) determining the susceptibility of aggregates to cracking caused by freezing and thawing; (3) establishing the impact of lateral pressures from expanding soils on basement walls; (4) analyzing plans for coal mining, and (5) ensuring that appropriate rock strength properties are used in construction design.

- The Inter-Survey Geotechnical Laboratory processed 6,600 samples for various parameters during the year, contributing valuable information to a number of research and service projects. It also supervised the sampling of surficial materials, including shallow drilling operations.

- Geotechnical services included: (1) providing information on construction conditions and water supplies on nine prospective factory sites to the Department of Commerce and Community Affairs; (2) providing information on the Wilsonville hazardous waste site; and (3) providing bearing strength information of specific rock units to a company designing concrete vaults to store wastes.

GENERAL AND BASIC RESEARCH

Major Equipment

- The major equipment provisions contained in the 1986 "Build Illinois Program" for the three scientific surveys are a landmark. As a consequence, 1 million dollars worth of scientific equipment has been approved for delivery to the three Scientific Surveys in FY 1986. In addition, 2 million dollars has been committed for delivery of major equipment in FY 1987. The program will enable the Surveys to attain state-of-the-art equipment status in a number of scientific areas, to measure in parts per billion what used to be measured in parts per million, and to retain and attract qualified people in the highly competitive environment for research scientists.

Geologic Mapping

- A cooperative agreement with the USGS has extended the COGEOMAP program for a second year of detailed geologic mapping in southern Illinois. The program has revealed coal seams not previously mapped, adding to the state's known coal resources. Previously unknown structures have been mapped; their interpretation may provide incentives for oil and gas exploration.

- Geologic maps for the Shawneetown, Equality, and Rudement 7.5-minute Quadrangles are currently being published. Field work is nearing completion on the Creal Springs and Eddyville Quadrangles; work is progressing on the Stonefort, Glendale, and Waltersburg Quadrangles.

- Surficial geological studies have shown that the biological condition of stream water in the Vermilion River Basin is a function of sandy soils along the Edwards River valley of Mercer County.

Geophysical and Geochemical Investigations

- The ISGS submitted a proposal for 300 miles of seismic profiling to the Consortium for Continental Reflection Profiling (COCORP) to obtain deep information on the nature of the earth's crust in southern Illinois, especially south of the 38th parallel where no wells have been drilled to basement.

- A seven day per week operational schedule has enabled the ISGS Radiocarbon Dating Laboratory to achieve a 40 percent increase in productivity in 1985 compared to the previous year.

- Radiocarbon dating suggests that the high levels of Lake Michigan during the highest lake level phase about 12,500 years ago was controlled by the volume of water coming into the lake, not by the threshhold altitude of the outlet sill.

- Basic geochemical studies continue to provide information helpful in explaining such wide-ranging phenomena as the food chain most

responsible for the growth of fish and the source of oxygen depletion in a compressed air energy storage site.

Clay Mineralogy

- Basic clay mineral studies are concentrating on the mechanism and rate of alteration of mineral constitutents caused by different types of plants and on the origin of clay minerals as detrital, diagenetic, or authigenic in Paleozoic strata in Illinois.

- Compositional and physical data on clay minerals in Quaternary strata in 15 counties are being synthesized to produce a regional map and publications that will portray the nature of clay materials for land burial and containment of wastes, for clay resources, for delineating areas of expansive soils, and for controlling the development of landslides.

Stratigraphic Investigations

- Regional correlations of Illinoian and older loess deposits are being established.

- Lithostratigraphic units of the Quaternary Wedron Formation have been identified, correlated, and their depositional environments interpreted.

- Clay mineralogy, radiocarbon dating, and lithologic descriptions were used to establish stratigraphic units in a U.S. Corps of Engineers seepage control project near Mound City, Illinois. Quaternary floodplain, valley-train deposits, and underlying Eocene and Paleocene deposits were recognized.

- Ordovician tuffs have been altered to mixed-layer illite/smectite and to potassium feldspar in the Upper Mississippi Valley Region. Potassium-argon dates indicate formation of the authigenic K-feldspar during early Devonian time and the formation of the illite/smectite during early Mississippian time. Correlations of the K-bentonite beds have been established over broad areas by unique chemical fingerprints.

- Continued refinement of the age of the Everton Dolomite indicates that it is the only Ordovician Whiterockian formation in the mid-continent and that it occurs south of a pinchout line that extends from near St. Louis through a position near Vandalia to one near Lawrenceville in southeastern Illinois.

- Studies of Silurian lithostratigraphy and biostratigraphy have been renewed.

- A joint effort between the Illinois, Indiana, and Kentucky Geological Surveys continues to resolve differences in stratigraphic terminology of the Pennsylvanian System.

- The ISGS contributed correlations to the recently published COSUNA charts for the Midwestern Basin and Arches Region.

Subsurface Geology

- A summary article on the Illinois Basin has been prepared at the request of the Geological Society of America and includes new data on the recently discovered Grayville Graben and on the Rough Creek and Mississippi Valley Grabens.

- Lithofacies and isopach maps have been prepared of the Sauk Sequence, the oldest Phanerozoic rocks in the mid-continent.

- More than 120 scientists took part in a workshop held in Urbana-Champaign to further develop plans for the proposed IBUD--one of 14 proposed drillholes selected for further study by the Scientific Advisory Committee of DOSECC (Deep Observation and Sampling of the Earth's Continental Crust, Inc.). Their efforts resulted in the creation of a 300-page plan and budget estimate.

Structural Geology

- A report on the Ste. Genevieve Fault Zone noted two important periods of vertical movements, the first in late Middle Devonian time and the second, larger episode, in late Mississippian and Pennsylvanian time.

- Work is progressing on three additional documents, one on the geologic history of the Shawneetown Fault Zone, one on thrust faults in southern Illinois, and one an encyclopedia of all structural geologic features in Illinois.

Paleontology/Palynology

- Rod Norby has been appointed curator of all paleontologic collections at the ISGS, following the retirement of Dr. Kent.

- Trace fossils are being studied in Pennsylvanian rocks to distinguish marine from non-marine sandstones. Ammonoids have also been found and are being studied for faunal affinities and correlations with neighboring states and Europe.

- Upright fossil tree stumps have been found in the Pennsylvanian Energy Shale rooted in the underlying Herrin coal.

- New palynological data suggest that Atokan-Desmoninesian boundary be raised and the Westphalian C-D boundary be lowered to the same position. It has also been proposed that the significant palynological changes at the Desmoinesian-Missourian boundary were triggered by a reduction in atmospheric CO_2 and a temporary change to a semi-arid climate due to glaciation in the southern hemisphere.

- Palynological determinations have been used in the COGEOMAP program to correlate coals found in drill holes. Palynological identification and/or counsel, and advice were provided to the Arizona and Missouri Geological Survey, to a coal company in Franklin County, and to several graduate students at Illinois, Iowa, and Louisiana, and to a professor at Pennsylvania State University.

Computer Research and Services

- Dr. Donald McKay was appointed head of the new section on Computer Research and Services.

- The GIS has been extensively used in developing maps for a number of projects, including the Illinois-Michigan Canal project, the Environmental Atlas for the State of Illinois SSC proposal, the LTER project, Geology for Planning project in Perry County, and the effort for siting the Chrysler-Mitsubishi facility near Normal, Illinois.

- The GIS was also used to prepare a demonstration series of maps to illustrate possible high-risk areas for earthquake damage in Richland County for the Illinois Emergency and Disaster Agency.

- Computer automation proceeded for invoicing certain Satellite Image Map orders for the Geologic Records Unit, and for annual waterflood and oil production statistics. Data processing services provided significant support for research and operations at the Survey and for others in a variety of projects.

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES

Publication, Graphics, and Photography

- The Publications, Graphics, and Photography unit expanded graphics products and services, initiated consultative analysis and structural editing, and introduced product conceptualization and development.

- The unit was involved in 137 publications projects.

Information and Technical Services Unit

- The Information Office continued to meet the public, answer questions, and provide publications. The switchboard handled phone calls at a projected rate of 35,316 for the year. The mailroom distributed publications, maps, and correspondence totalling 70,153 individual pieces through the postage meter.

- High volumes of material were also handled through the ISGS duplicating and well log copying services.

Word Processing Center/Technical Records Unit

- Expert services were provided to the ISGS word processing operators and to handling work overloads at any one station.

- The flow of incoming mail was expeditiously carried out and technical record files were maintained of important mail not retained by the various Group offices.

Technical Design, Operations, and Maintenance

- The General Shop was involved in the design, construction, fabrication, installation, modification, maintenance, management, and supervision of 315 jobs involving internal work orders.

- The Electronics Shop provided services for 155 work orders.

- Personnel oversaw the replacement and maintenance of the Survey's fleet of vehicles.

Library/Map Room

- Library services showed a dramatic increase. Reference questions increased 100 percent and interlibrary loans increased substantially.

Human Resource Office

- The Personnel Office was renamed and duties expanded to include employee evaluation procedures, salary progression matters, and coordination of workshop/training courses for employees.

- Searches for qualified candidates for key positions received major emphasis.

Capital Development Board Projects

- A multipurpose building was erected northeast of the Natural Resources Annex to house a Technical Design, Operations, and Maintenance Shop and Duplicating Services. Work space has been provided for indoor maintenance of large pieces of equipment heretofore kept outdoors because of lack of space. Storage areas are provided for such pieces of equipment as drill rigs and sampling and monitoring equipment used in the field and in lake and river investigations.

Educational Extension and Public Relations Unit

- Four geological science trips were held for teachers, students, and the public near Salem, Elizabeth, Pekin, and Lawrenceville.

- Educational support was given to teachers and students of secondary schools by providing rock and mineral sets, responding to phone calls and letters, and giving lectures and workshops.

- Educational exhibits and displays were also provided at a number of meetings and functions at various places in the state.

ACTIVITY MEASURES

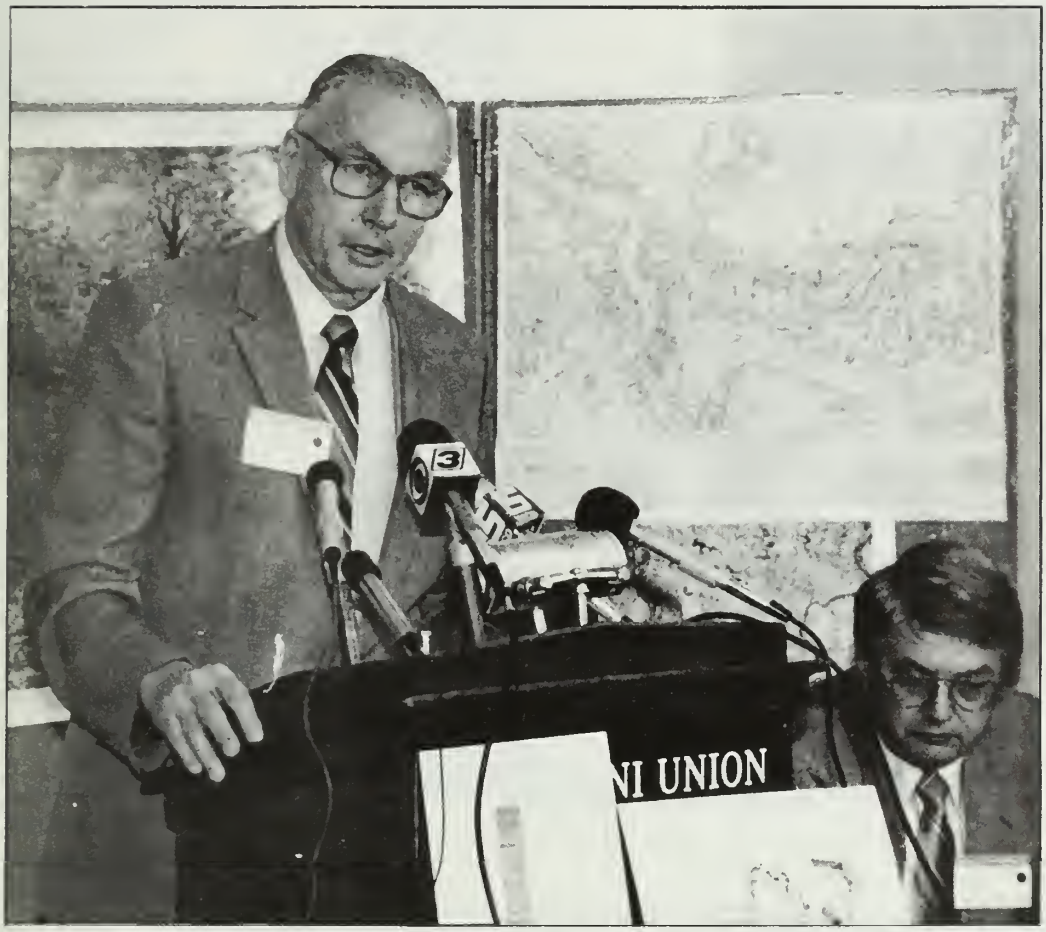
- The total number of copies of ISGS publications distributed (49,345) is 55 percent greater than last year's total. It includes 13.8 percent more reports, 201 percent more ISGS maps, and 12.6 percent more USGS map products. Included in these figures is the extraordinary demand for the Satellite Image Map.

- While we experienced a significant drop to 189 in the number of reports and maps published, the number of unpublished reports, memos, and other responses nearly doubled to 1,684.

- Survey personnel gave 410 lectures, talks, and presentations; contributed to 108 workshops, classes, and seminars; received 9,627 visitors; handled 9,420 telephone inquiries; and responded to 5,175 letter inquiries.

- Major increases were recorded in the Survey's activities related to Grants and Contracts.

MINERAL RESOURCES RESEARCH AND SERVICES



Morris W. Leighton, Chief, and J. James Eidel, Head of Mineral Resources Group, brief reporters at a press conference in April 1986 concerning the ISGS proposal for a Scientific Superdeep Drillhole in the Illinois Basin. Proposed depth: 30,000 feet.

Dennis R. Kolata, Co-chairman of the Basin Analysis Working Group on the Illinois Basin Superdeep Drillhole, led discussions.

Workshop organizer J. James Eidel, Principal Geologist and Head of the Mineral Resources Group, opened the technical sessions on April 2, 1986, with a talk to the participants.

A highlight of the workshop for geologists and geophysicists was the opportunity to examine seismic data on the Illinois Basin—proprietary data acquired by Companie Generale Geophysique.

MINERAL RESOURCES RESEARCH AND SERVICE PROGRAMS

Mineral research and service at the Illinois State Geological Survey is designed to provide incentives for the mineral industry to explore and wisely develop the State's resources:

- coal oil, and gas
- industrial minerals--limestone, dolomite, sand and gravel, fluorite, lead, zinc, beryllium, thorium, and rare earth minerals.

New data may point to regions where previously unsuspected resources could be present, indicate new exploration strategies, or lead to unconventional ways of extracting, processing, and using mineral resources.

Survey scientists are continuing to focus on developing efficient, low-cost methods of removing sulfur from high-sulfur Illinois coal to increase its marketability and use Ways are also being sought to remove sodium and chlorine (which cause corrosion and other problems in boilers) from Illinois coals. Continued basic and applied research on the deleterious, as well as the potentially valuable, minor constituents of coal are imperative given the low level of national effort in this field and its importance to the Illinois economy.

Oil and gas production from the Illinois Basin (as from other U.S basins) is characteristically episodic: a new idea, a new play, a new and deeper field, or a significant advance in the technology for tertiary oil recovery could significantly alter the historical production curve for Illinois. As this episodic history suggests, production in Illinois could again increase significantly.

Sand gravel, and stone account for more than 88.9 percent of Illinois industrial mineral production; the construction industry is the largest consumer of these materials. As reserves at existing quarries become depleted and urban sprawl encroaches on potential quarry sites in large metropolitan areas, the search for new sources of crushed stone for construction of roads and buildings becomes urgent. Survey scientists are playing a significant role in this search--identifying sources of construction aggregate, evaluating their quality, and investigating the feasibility of underground mining to ensure future supplies.

Several new efforts to assess Illinois mineral resources are underway. Among them is a joint ISGS/USGS Conterminous U.S. Mineral Appraisal Program (CUSMAP) that will be initiated in FY 87 for the Paducah 1° by 2° (1 250,000) sheet. This mapping effort covers all of Illinois south of the 38th parallel. State funds for this program are included under the ISGS Expanded Mapping Initiative.

Mineral production data for 1984 and 1985.

Commodity	Unit	1984 Quantity	1984 Value (thousand $)	1985 Quantity	1985 Value (thousand $)	Percentage of change from 1984 to 1985 Quantity	Percentage of change from 1984 to 1985 Value
MINERAL MATERIALS MINED							
Fuels							
Coal	thousand tons	65,289	1,951,494	60,600	1,757,400[a]	- 7.2	- 9.9
Crude oil	thousand bbl	28,870	830,400	30,000[a]	840,000[a]	+ 3.9	+ 1.2
Natural gas	thousand Mcf	1,530	4,254	1,324	3,668[a]	- 13.8	- 13.8
Industrial and construction materials							
Stone	thousand tons	48,500	191,600	44,002	184,117	- 9.3	- 3.9
Sand and gravel	thousand tons	30,069	124,674	29,300	127,300	- 2.6	+ 2.1
Clays[b]	thousand tons	253	940	228	846	- 9.9	- 10.0
Fluorspar	thousand tons	W	W	W	W	- 3.0	- 3.0
Tripoli	thousand tons	W	W	W	W	- 3.8	- 3.8
Metals							
Lead	tons	W	W	W	W	- 42.7	- 57.0
Zinc	tons	W	W	W	W	- 27.3	- 39.4
Silver	troy ounce	W	W	W	W	--	--
Other							
Peat	thousand tons	W	W	W	W	+ 8.2	+ 16.8
Gem stones		NA	15	--	15	--	--
Barite, primary	thousand tons	W	W	W	W	- 50.0	- 59.0
Values that cannot be disclosed (W)		-	32,941		34,476	--	+ 4.7
Total value of mineral materials mined			$3,136,318		$2,947,822		- 6.0

[a] Estimated by ISGS

[b] Excludes fuller's earth; included with value of items indicated by symbol W.

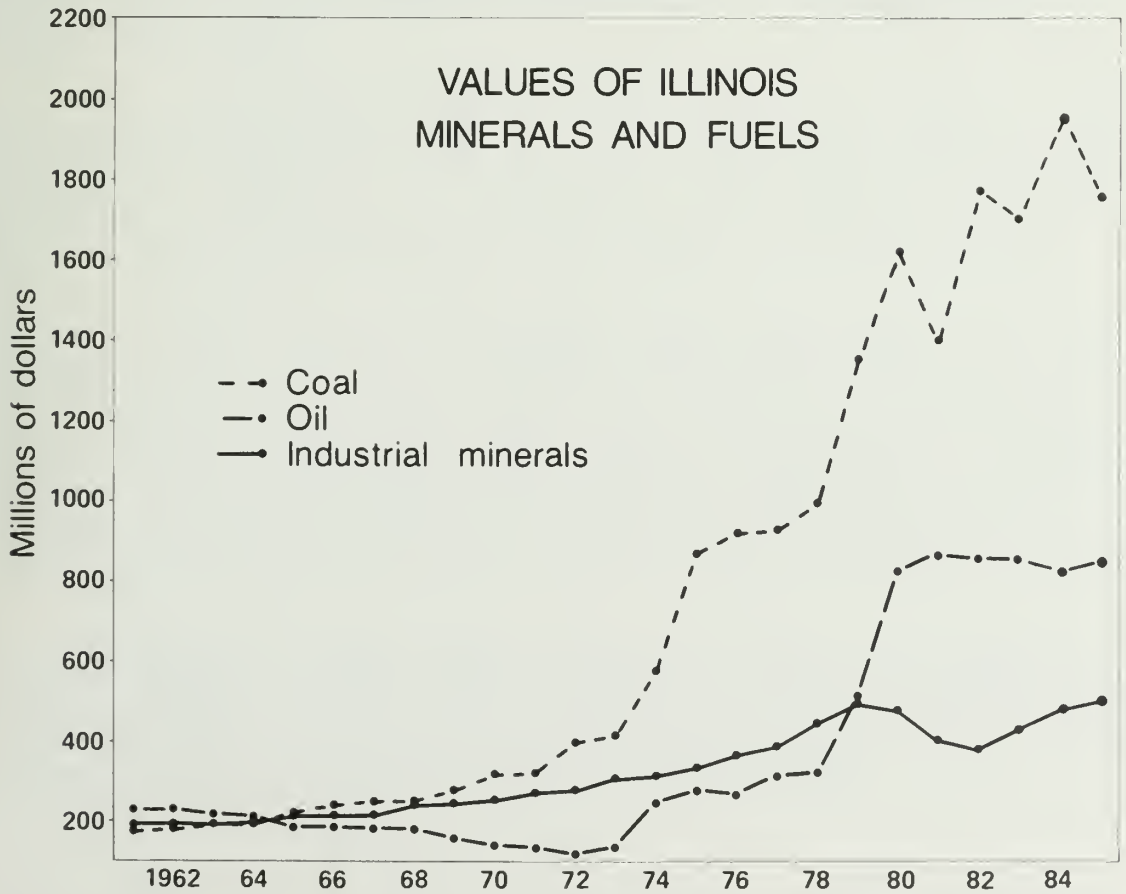
W = Withheld to avoid disclosing individual company confidential data.

ILLINOIS MINERAL INDUSTRY IN 1984 AND 1985

The 1984 mineral production in Illinois was valued at approximately $3.14 billion. an increase of 9.4 percent over 1983. The total 1985 value of all minerals produced in 1985 was about $2.95 billion or about 6 percent lower than in 1984. (Figure 1 shows long-term trends.)

In 1984, coal and oil and gas accounted for 88.8 percent of the total value while stone, sand and gravel and clays for 10.1 percent. All other minerals together contributed 1.1 percent to the total value of minerals produced in 1984. Coal production in 1984 was the highest since 1972 and the second highest since World War II. Coal remained the most important mineral in Illinois with a value of about $1.95 billion or 62 percent of the state's total mineral production. The main reason for the record coal production was advance purchasing by utilities in anticipation of a possible mine workers' strike in the contract renewal year 1984.

Utilities in 1985 reduced their purchases of coal and lowered their stockpiles following the settlement of wage negotiations. Due to reduced demand and lower prices, coal production in 1985 declined by 7.2 percent and value by 9.9 percent from the 1984 levels. Oil production in 1985 was 3.9 percent higher than in 1984 but its total value is estimated to have risen only by 1.2 percent due to price declines.



Several energy-related bills were signed by the Governor in 1985. The most significant are as follows:

HB-0018-- changes the tax on gas to 5 percent of gross receipts or 2.4 cents per therm of gas sold and on electricity to 5 percent of gross receipts or 0.32 cents per kilowatt hour, whichever is lower.

HB-1184-- requires the use of Illinois coal as a condition for receiving alternative emission standards or variance of sulfur dioxide emmissions for coal-burning stationary sources.

HB-1202-- as an amendment to the Comprehensive Solar Energy Act of 1977, provides for a grant of 20 percent of the first $10,000 spent on solar energy systems for single family residential buildings and of the first $50,000 for other buildings.

SB-0662-- established a Solar Energy Refund Program under which the Department of Energy and Natural Resources will refund 20 percent but no more than $1,000 of investment in a department certified solar system.

SB-0254-- provides that the 1 percent tax on gasohol, which is in effect until 1993, will increase by one percentage point when the federal excise tax on gasohol decreases by 1 cent per gallon of gasohol.

COAL

ISGS Coal Research and Service Program

Industry government, and private citizens benefit from the Survey's Coal Program, which provides authoritative and current information on the state's vast coal resources and promotes development and wise use of this valuable resource.

Our studies concentrate on identification, quantification and characterization of the State's coal resources, and on determining the properties of rocks that influence minability of coal seams and subsidence after mining. A major effort goes into the study of the occurrence nature, and removability of sulfur and chlorine in coal as well as of other elements that impact the development of Illinois coal. Many of the Survey's research projects in these areas are coordinated with, and supported by, the Center for Research on Sulfur in Coal (CRSC).

Activities of the Coal Mining Industry (Damberger Morgan, and Bhagwat). Concern about the near and long-term future of the Illinois coal-mining industry remains high. A Wisconsin law limiting SO_2 emissions from coal-burning power plants will restrict sales of Illinois coal in this traditional market. On the other hand, the industrial boiler market--lost to natural gas and heating oil after World War II--will open up as a result of demonstrating that fluidized-bed combustion (FBC) boilers are cost effective and capable of satisfying pollution-control requirements.

One underground mine was abandoned; another was opened. Permit applications for one new coal mine are under review by the Illinois Department of Mines and Minerals. This underground mine would be located near Oakland in northeastern Coles County, east-central Illinois, to take advantage of Herrin (No. 6) Coal with a low to moderate sulfur content. Coal will be supplied to a major industry.

Coal exploration activity stayed near the depressed level of the previous year. Fourteen companies filed 1,868 drillhole plugging affidavits with the Illinois Department of Mines and Minerals and the ISGS; 1,504 were filed last year. Most drilling was undertaken near active surface mines. Only about 118 drillholes were sufficiently distant from existing mines to be considered exploration borings; this compares to about 250 similar holes drilled the previous year. The difficult coal market continues to severely limit expenditures for coal exploration.

Pittsbury and Midway Coal Company, a subsidiary of Chevron Oil Company signed a lease/purchase agreement with Cave Township Coal Association, consisting of local landowners who control 170 million tons of deep-minable coal reserves of medium sulfur Springfield (No. 5) Coal and high sulfur Herrin (No. 6) Coal in Franklin County.

Coal production in 1985 fell from the previous year's high of almost 65 million tons to about 61 million tons--reflecting a reaction to the previous year's buildup of stockpiles at utilities in anticipation of a coal miners' strike. Demand slackened when a strike was averted.

Coal Resources and Geology

Coal Exploration Records (Morgan). During this report period 531 feet of core descriptions have been added to the confidential files of the Coal Section. They were obtained from 24 drill holes in 4 counties of Illinois. In addition we received 30 drillers' logs to add to our files.

As shown from the coal-plugging affidavits received, drilling activity in Illinois has been mostly developmental around existing mines. Exploratory drilling was as low as it has been in recent years. Companies known to be actively drilling include Amax Coal, Arch Land, Consolidation Coal, Energy Supply, Exxon Coal Resources, Inland Steel, Kerr-McGee, Monterey Coal, Old Ben, Peabody, Shot Point Services, and Zeigler Coal.

Stratigraphic Correlations of the Seelyville, Dekoven, and Davis Coals in the Illinois Basin (Jacobson). Completed during the report period, this study determined that the minable Dekoven and Davis Coals of southern Illinois, Indiana, and western Illinois are correlative to the Seelyville Coal, an important economic coal in east-central Illinois and west-central Indiana. Apparently the Davis Coal is of minable thickness throughout much of southeastern Illinois northward to the area where it has been mapped with the Dekoven as the Seelyville Coal. This discovery led to a project to evaluate the resources of the Dekoven and Davis Coals in southeastern Illinois.

Coal Resources of the Dekoven and Davis Coals of Southeastern Illinois (Jacobson). A study is underway to evaluate the Dekoven and Davis Coal resources in Saline, Gallatin, Hamilton, White, Edwards, Wabash, Wayne, Lawrence, and Richland Counties. Although this zone contains substantial resources, it has not been mapped between the actively mined region of southeastern Illinois and the Seelyville Coal of east-central Illinois and Indiana, which was mapped by C. G. Treworgy (IMN 80, 1981). The coal has a high heating value, and in some areas, a low to moderate sulfur content. An investigation of the gap between the two mapped areas was initiated after completion of the correlation project for this interval.

Information being compiled in a computer format includes thickness and depth of the Dekoven and Davis; interval thickness between the Dekoven and Davis Coals, nature of the lithology of this interval; and depth and thicknesses for several coals and limestones beneath the Davis Coal.

Geology of Herrin (No. 6) Coal in Central Illinois (Nelson). A report entitled "The Hornsby Deposit of Low-Sulfur Coal, West-Central Illinois" is undergoing editorial review for publication as an ISGS Circular. It discusses the geology and mining conditions of the Herrin (No. 6) Coal in Christian, Macoupin, Montgomery and Sangamon Counties. This region contains an estimated 1.17 billion tons of coal with less than 2.5 percent sulfur--resources that have been barely touched by mining to date. Roof conditions in the low- to moderate-sulfur coal are expected to be less favorable than in adjacent high-sulfur deposits, but mining companies should be able to control the roof and extract the low- to moderate-sulfur coal profitably.

Coal Mining Geology

Computerized Coal Stratigraphic Database (C. Treworgy and Bargh). Phase I of this project to develop a computerized database of coal stratigraphic data has been completed. Data from more than 2,700 mines, borings, and outcrops have been entered into the database on ENR's Prime computer. Geologists can access the data through a series of menus that permit retrieval of points by specific parameters such as location or geologic unit. The data can be displayed on a terminal or printed, plotted as maps, or transferred to other programs for contouring or statistical analysis.

Phase II of this project to be completed by mid-1986, will add about 8,000 points to the database. The data points were collected in computer-processable form by Coal Section staff over several decades in connection with various coal resource programs and projects.

Computerized Mined-Out Area Database (C. Treworgy and M. Bargh). Outlines of more than 5,000 surface and underground coal mines have been entered into a computer file using the ENR geographic information system (GIS) on the Prime computer. These outlines include all areas that have been mined up to 1984. Using the GIS these data can be merged with other data on coal resources, land cover, and geology to provide information on remaining resources and subsidence potential.

Composition of Coal

Information System on Chemistry of Illinois Coals (ISCIC) (Harvey, Kar, Bargh, and Kohlenberger). This work established a computerized database of proximate, ultimate, and other standardized (ASTM) chemical results on Illinois coal. Retrieval software was developed so that the public can work with the data from remote computer terminals. The data and software, described as ISCIC, were established with the aid of funds from the Illinois Coal Research Board on a University of Illinois mainframe computer.

Information System on Illinois Coal: II. Characterization of Samples in the Illinois Basin Coal Sample Program (Harvey Kar, Bargh, and Steele). An outgrowth of the preceeding project, this work is also funded by the Ilinois Coal Devevelopment Board. It will establish data

files comprising the names of investigators who received samples through the IBCSP, and brief descriptions of their research. In addition, chemical and petrographic analyses of coal and mineral matter are being determined and will be a part of the information system. The design of the system has been completed, and it is being set up on the University of Illinois Cyber-175 computer to make it readily accessible to all coal investigators. To date the four samples in the program have been characterized for their petrographic composition and their minor and trace-element contents.

Management of Data on Illinois Coal Resources. FY86: Chemical, Mineralogical, and Petrographic Properties (Harvey, Steele, and C. Treworgy). A proposal on the subject was funded by the U.S. Geological Survey. The main objective of this project is to reformat our data files on the proximate, ultimate, minor, and trace element analyses of Illinois coals to conform to the format needed by the U.S. Geological Survey's National Coal Resources Data System (NCRDS). The Coal Section will then transfer these data to the NCRDS. The data will significantly aid the national effort as the NCRDS now contains little data on Illinois coals. The second objective is to sample five Illinois mines that have not been sampled to date and to determine their chemical, mineralogical, and petrographic analyses. These new data will also be transferred to the NCRDS. During the course of this project there will be an opportunity to make considerable progress in developing our own computer management system to handle these numerous data.

To date the Coal Section has (1) converted the main program for maceral analysis from a "Basic" to a "Fortran" program, (2) written a similar program to manage mineralogical data and (3) set up an INFO database of proximate and ultimate analytical results. In addition, contract funds provided by the U.S. Geological Survey will allow for the purchase of a new PC version of INFO that will run on an IBM PC/AT. These acquisitions set the stage for rapid progress in management of data on coal quality and related coal resources.

Mineral Matter in Illinois Coals (Harvey, Lowry, and Ruch). Mineral impurities in coal are generally deleterious for steam generation at utility plants and add considerably to the cost of plant operation. Investigations of mineral matter in coal are continuing (1) to expand the database on mineral analyses, (2) to identify patterns of mineral occurrences in particular seams, and (3) to improve methods of analysis. Low-temperature ashing (LTA) liberates minerals from coal without destroying them, thus enabling a relatively precise analysis of the minerals in the ashing residue on a routine basis. For the latter analysis, X-ray diffraction is used. During this year LTA and X-ray analyses were completed on 38 samples in support of several Survey projects and 37 samples in cooperation with coal investigators at other institutions.

Composition of Clay-Rich Partings in the Herrin (No. 6) Coal (DeMaris, Hughes, and Warren). The composition of clay-rich partings in the Herrin Coal is being examined both to identify differences in depo-

sitional environments that alter clays, and to better characterize widespread clay partings, which constitute an undesirable component of the coal for many uses. Preliminary analysis of data for the "blue band" as it thickens along a transect toward the Walshville channel has revealed more intensive clay alteration away from the channel than near it. More than 80 samples are currently being analyzed.

Sodium, Chlorine and Sulfur in Illinois Coals: Removal by Physical Cleaning, and Behavior During Combustion (C.-L. Chou, Demir, Cahill, Chaven, Winston, and Sotomayor). Sodium and chlorine in Illinois coals hinder the marketability of at least half of the State's economically minable coal reserves; most of the high-chlorine coal is also high in sulfur.

An investigation, supported by the Illinois Coal Development Board, of the distribution of Cl, Na, S and ash in hand-picked coal lithotypes showed that Cl is concentrated in the organic portion of coal, and Na tends to be concentrated in the mineral matter. Vitrain separates are highest in Cl and lowest in Na and ash. Leachability studies of Na, Cl, and other elements showed significant variability between coal lithotypes. Under laboratory conditions, coal can be finely ground to -325 mesh and leached with hot water (93°C) or soaked with water at room temperature for several days and then leached: nearly all the Cl in coal is removed.

Elemental Abundances in Coal Lithotypes of Herrin (No. 6) Coal, Illinois Basin (C.-L. Chou, Winston, and Cahill). The composition of a face channel sample is controlled by its lithotype abundances. New data on a complete 1.76-meter vertical column of the Herrin (No. 6) Coal from Jefferson County, Illinois, indicate that vitrain is lowest in ash content and in elements associated with pyrite and clay minerals, but highest in the Cl content. Dull coal is high in ash and in lithophile (e.g., Si, Al, K) and chalcophile elements (e.g., Fe, S, Zn). The concentrations of elements vary more in fusain than in other lithotypes because the pore spaces of original plant structure have been mineralized with pyrite and calcite to varying degrees.

Aqueous Leachability of Sodium and Chlorine from Coal Lithotypes (Demir, C.-L. Chou, and Chaven). Studies of Na and Cl in hand-picked lithotypes of the Herrin Coal indicate a close correlation between the leachability of these elements and the distribution of pores within coal. With increasing microporosity, relative amounts of Cl adsorbed on organic surfaces and Na adsorbed on clay minerals increase. With increasing macroporosity and decreasing amounts of clay, the relative amount of Na and Cl present as dissolved salt in pore water rises. Aqueous leachabilities of Na and Cl from the lithotypes increase from vitrain through bright banded, sub-bright banded, and dull coal to fusain, perhaps reflecting increasing relative amounts of Na and Cl in dissolved salt form due to the increasing number of large pores in these coal lithotypes. Raising temperature and soaking time prior to leaching increases the leachability of Na and Cl from lithotypes: for example, stirring one part of coal in five parts water at 93°C for 30 minutes,

for example, resulted in the dissolution of 79 percent of Cl from vitrain, 89 percent from sub-bright banded coal, and 100 percent from fusain. High temperature and increased soaking time apparently open up the pore structure and increase the rate of diffusion and ion exchange involving H^+, OH^-, Na^+, and Cl^- in the water-coal system.

Determination of Zeta Potentials of Coal Lithotypes in Aqueous Solutions (Demir and C.-L. Chou). Electrostatic charge on the surface of coal particles affects adsorption of impurities by coal, as well as surface-dependent coal-preparation processes such as flotation and aggregation. To study these relationships and seek optimum conditions for fine coal cleaning, Zeta potentials are being determined for coal in aqueous solutions. The Zeta Potential is a direct measure of electrostatic charge at the coal-water interface. Zeta potentials for an initial set of five hand-picked coal lithotypes suspended in distilled water were measured as a function of pH using a ZM3-83 zeta-meter. The influence of the pH on the surface charge was found to be greatest for vitrain and smallest for fusain as the pH was gradually raised from 3 to 7.

Organic Geochemistry of a Pennsylvanian Organic-Rich Shale in the Illinois Basin (Mei-In M. Chou). The hydrocarbon composition of the Anna Shale is being studied in order to gain a better understanding of depositional and postdepositional processes affecting the organic constituents of this member of the Pennsylvanian-aged Carbondale Formation, a widespread shale overlying the Herrin (No. 6) Coal. The extractable aliphatic hydrocarbon of the Anna Shale samples contains a considerable amount of nonpristane, pristane, and phytane; whereas the Energy Shale (nonmarine) samples contain a large amount of normal alkanes. The data indicate that the organic-rich Pennsylvanian rocks in Illinois belong to a geochemical facies between facies #3 and #4 as defined by Hatch and Leventhal (1985). The relatively high hydrogen indexes, organic carbon content, and metal contents, and low pristane/phytane ratio of the Anna Shale samples confirm the presence of anoxic marine bottom water that is also shown by the fossil asssemblage and sedimentary structures.

Coal Analysis

Chemical Methods Development (Chaven, Kohlenberger, and Kuykendall). The ISGS Coal Analysis Laboratory, besides performing routine ASTM analyses of coal and coal-related products, is continuing its effort in method improvement and evaluation of total sulfur and pyritic sulfur determinations in coal. A shift from standard wet chemical methods to state-of-the-art instrumentation continues. The ASTM method D3177 for total sulfur has now been superceded by a microprocessor-controlled, oxygen-combustion instrument. The oxides of sulfur are quantified by an infra-red cell. The method is rapid and precise; however, in those coals with high ash contents, low sulfur values can be obtained. The error inherent in this method leads to an erroneous organic sulfur estimation. Therefore, various combustion catalysts are being evaluated for their ability to completely liberate any sulfur remaining in the ash.

The ASTM determination for pyritic sulfur is also being evaluated. The method works well for coal, but again difficulties occur in samples with high ash. Attempts are being made to overcome these difficulties.

Thermal Analysis Laboratory (Rostam-Abadi and DeBarr). In 1983, with support from the Illinois Coal Development Board, a Thermal Analysis Laboratory (ThAL) was established at the ISGS Applied Research Laboratory. The laboratory has capability for the following thermal methods: thermogravimetry (TG), derivative thermogravimetry (DTG), differential thermal analysis (DTA), differential scanning calorimetry (DSC), and thermomechnical analysis (TMA). During the past year, these techniques were used in ISGS research projects and collaborative efforts with members of the Center for Research on Sulfur in Coal (CRSC) to characterize coals, coal ash, coal conversion by-products, oil shale, and coal-oil shale mixtures. Fundamental and engineering data have also been obtained on pyrolysis rates of coal, oxidation reactivities of coal chars, and softening and swelling properties of coals subjected to a variety of chemical and physical treatments.

The TMA unit is the most recent addition to the ThAL. It was recently used as a microdilatometer to measure caking (agglomerating) properties of coals and to study methods by which caking can be minimized during thermal processing. Preliminary results, using an IBCSP#4 standard coal sample, have led us to investigate further an approach to reduce coal agglomeration by addition of a small amount of pyrite concentrate to a clean coal fraction. The resulting increase from 0.35 to 1.5 in the pyritic to organic sulfur ratio (P/O) caused a 260 percent decrease in swelling. This work has led to a new and important line of investigation concerning the very critical problem of agglomeration in Illinois coals.

Other research activities in the ThAL included determination of oxidation reactivities of a coal char produced in Allis Chalmers' Pilot facilities (Milwaukee) and obtaining the yields of pyrolysis products (oil, gas, char, water) for each of the four coals in the IBCSP by a Fischer Assay method.

Computer Applications (DeBarr, Rostam-Abadi, Chaven, Stephenson, and Mirza). Efforts continued at the ISGS Applied Research Laboratory to automate a number of research instruments and to develop a variety of scientific software. Phase one of this project, which has been completed, interfaced several thermoanalytical instruments of the Thermal Analysis Laboratory (ThAL) with IBM personal computers for automatic data collection and storage. Phase two has been the development of menu-driven and user-friendly programs for acquisition, storage, and management of data. The third phase of this project, which is currently in progress, is to interface a 2-inch bench-scale batch fluidized-bed reactor with an IBM-XT computer and to develop software that would facilitate the operation and data collection capability of this system.

Applied Research Laboratory Machine Shop (Cooper). The Machine Shop has been primarily involved this past year in contract work related to the Charring and Fine Coal Cleaning Projects. These contract projects required evaluation of special equipment, design and construction of new parts, equipment installation, and maintenance.

Effort was also devoted to the design, purchase, and construction of shelving and manifold for barrels of coal collected under the ICDB Uniform Coal Bank program.

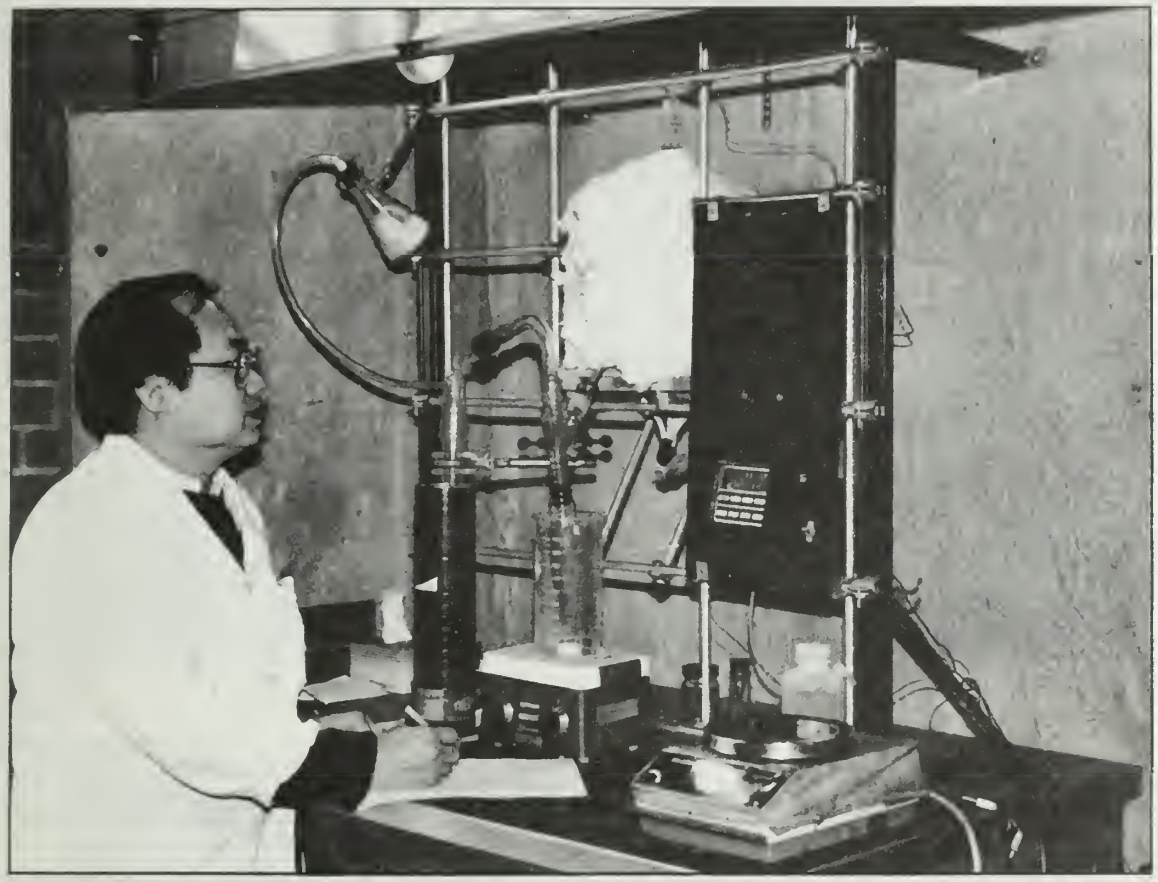
As a part of the general management and maintenance of the building's equipment, inventory records were maintained and repair operations were carried out for a broken hot water system and a broken vacuum pump.

Analytical Laboratory (Kohlenberger, Chaven, McMillion, Kuykendall, and Henry). From May through December 31, 1985, the Coal Analysis Laboratory analyzed samples at a rate of about 50 per month. Included were samples from CRSC projects, from both within and outside the Geological Survey. Charges for analytical services provided by the Coal Laboratory can now be handled easily and efficiently through the new University of Illinois Service account, which was initiated in 1985.

In addition to participating in both monthly and semiannual interlaboratory comparison studies (round robins), the Coal Lab is now using a daily control sample in a further effort towards quality assurance. The laboratory space for sulfur analysis has been doubled so that twice as many samples as before can be processed in a given time period. One more test has been added to the list of analyses routinely performed in the Coal Laboratory: the Fischer Assay.

Coal Desulfurization and Coal Cleaning

ISGS Coal Desulfurization Program. To comply with sulfur emission regulations for coal combustion, Illinois utilities plan to make greater use of flue-gas desulfurization. This decision is the outcome of nearly two decades of research and development, which clearly show that the technology has reached acceptable levels of efficiency and reliability when coals containing "moderate" amounts of sulfur (1.5% to 2.0%) are used. Higher sulfur levels result in excessive corrosion, unacceptable downtime, waste disposal problems and high operating costs. Moreover, flue-gas desulfurization is the only process technology available. Unfortunately, for most Illinois coals, cleaning to "moderate" concentrations of sulfur remains out of reach of conventional methods for pyrite removal. The successful development of the new ISGS aggregate flotation method, which is reported in this section, can fill the need for production of coal with a moderate level of sulfur. At the very least, it should help maintain the position of Illinois high-sulfur coal in the utility market. Consequently, this project now in pilot-scale operation at the ISGS, is particularly noteworthy. Because physical methods such as aggregate flotation do not remove organic sulfur forms, however, they are considered to be a short-term partial solution to the



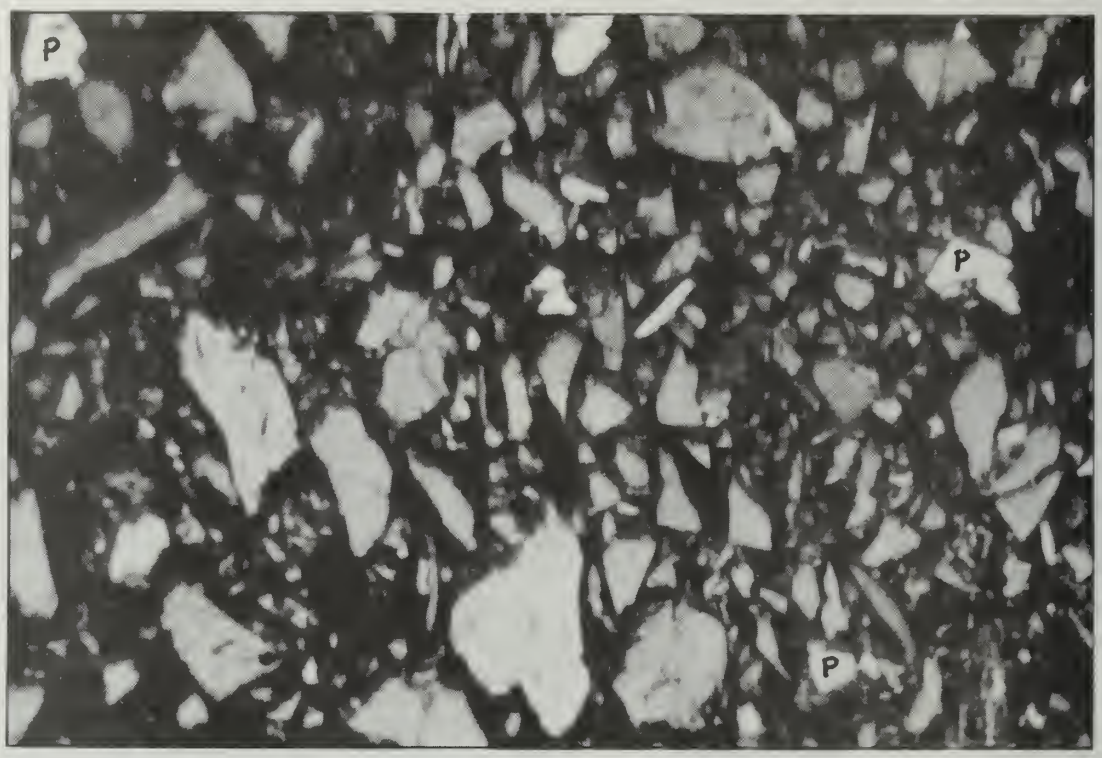
Chusak Chaven, Minerals Engineering Section, determines the tar and oil content of coal by means of the Fischer Assay procedure.

sulfur problem. In the long term, chemical and/or thermal desulfurization methods will have to be developed.

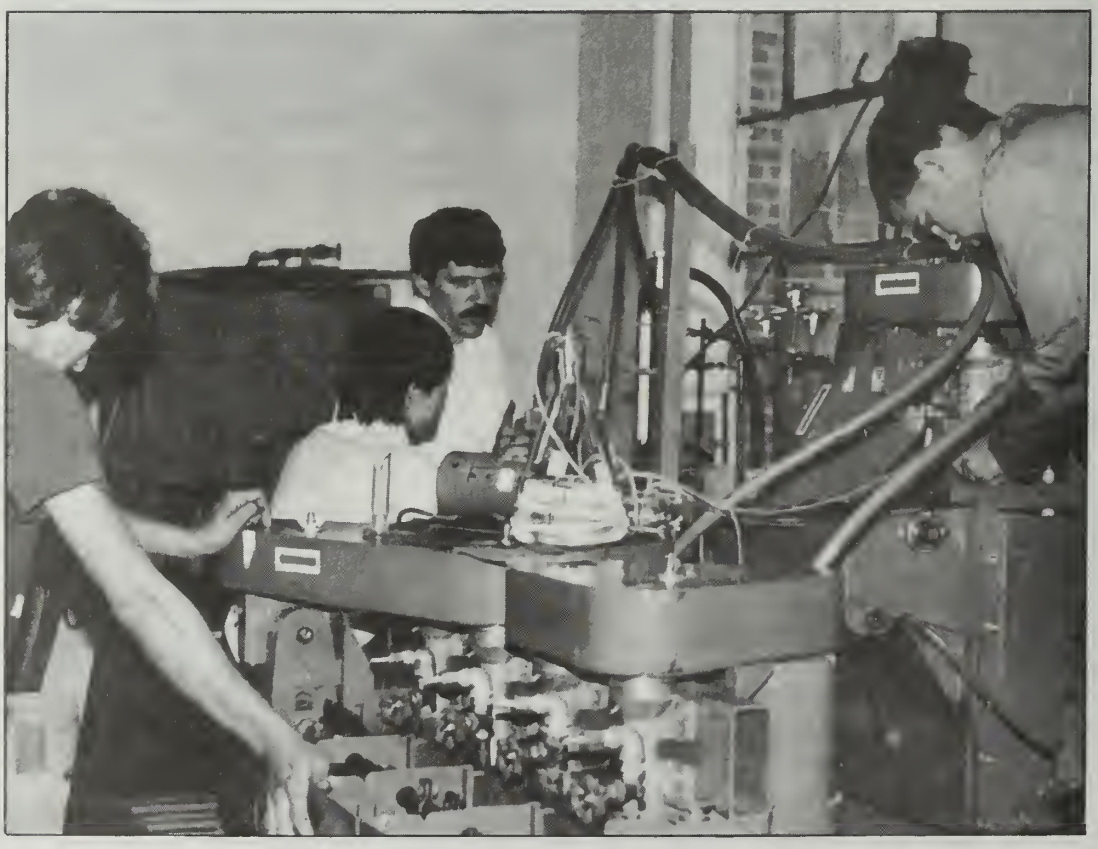
Also worthy of note is a new emphasis on advancing successful laboratory research projects to an engineering scale-up phase. In this regard, a new multidiscipline engineering task group is now operating, the function of which is to ensure that the work of chemists, engineers and geologists is efficiently integrated. Efforts by the task group have recently resulted in plans for bringing the carbon monoxide/ethanol (catalytic) process from the laboratory mode into the engineering mode and scale-up bench phase.

Much of this research effort has been undertaken in collaboration with other Illinois institutions through the Center for Research on Sulfur in Coal (CRSC). Its program has been largely funded by the Coal Development Board (CDB). Further details of individual projects follow.

Size and Maceral Association of Sulfide Grains in Illinois Coals and Their Washed Products (Harvey and DeMaris). The final report on this project, which was published as ISGS Contract/Grant Report 1985-2, indicates the finely disseminated nature of much of the pyrite in



Aggregate flotation concentrate containing liberated pyrite grains (P).



Initial operation of the continuous-flow apparatus for the ISGS aggregate flotation project. Dr. J. Fitzpatrick (center) of Northwestern University is working on this cooperative project.

Illinois coals and lends emphasis to the need for fine-coal cleaning. A poster paper on the subject was given at a national conference on coal quality hosted by the U.S. Geological Survey. A version of the report was presented at the annual meeting of The Society for Organic Petrology and is in press for Organic Geochemistry (Pergamon Press).

Spatial Distribution of Pyrite in Some Illinois Basin Coals and Its Effect on Liberation During Various Grinding Processes (DeMaris and Harvey). A proposal on this subject was submitted to the U.S. Department of Energy. During the course of the proposed 2-year study, basic data on size and distribution of pyrite grains will be generated and related to methods of grinding selected coals.

The ISGS Aggregate Flotation Fine Coal Cleaning Process (Erlinger, Read, Rapp, Camp, DeMaris, Ruch, Hughes, and FitzPatrick of NU). CRSC-funded research for developing a new fine-coal cleaning method has progressed through a series of evolutionary steps that incorporate some aspects of both froth flotation and oil agglomeration. Presently, the process focuses upon preferentially floating very fine-sized coal (<200 mesh) away from ash and pyrite using small bubbles, a foaming surfactant, a collector, and agitation. Test results on several coals indicate that a significant portion of the heating value (80%-90%) is retained, while a major amount (80%-90%) of the pyritic sulfur and ash-forming matter is rejected.

Progress was made in four areas:

- Under evaluation are preliminary gravity separations in which a shaking table is used to mechanically reject those portions of the pyrite and ash-forming minerals that are physically liberated from the coal particles by fine grinding. This has been successful on the "plant feed," thereby removing these undesirable constituents while upgrading the coal and reducing the amount of rejection needed in subsequent operations.

- A number of flotation tests have been conducted in the new Wilfley-Weber flotation machine that generates, by pneumatic means, tiny bubbles on the floor of the flotation cell. (A conventional flotation machine generates bubbles by pulling air into an impeller.) The very small bubbles generated by the Wilfley-Weber machine have greater surface attraction for fine coal and the quiescent zone in the cell is much larger. Increased recoveries support this observation indicating increased selectivity toward coal over pyrite and ash-forming minerals.

- Equipment was purchased to upgrade our batch testing to a small continuous-flow, pilot plant capable of treating a stream of about 20 pounds of coal per hour. "Shakedown" tests proving the viability of the circuit, show the need for an improved system prior to flotation, during which reagent addition and agitation time are well controlled. When the unit is completed, a series of tests based upon the best grind and reagent experience will be developed for each coal.

• Waste products from operating plants have been tested to determine their amenability to the Aggregate Flotation Process. Both plant outwash and plant gob-pile material have been tested and found to be usable feedstocks giving high Btu value, low pyrite, low ash, and acceptable recovery.

Significant petrographic, mineralogic, and chemical characterization efforts have been done in support of these tasks.

Characterization of Materials in the ISGS Aggregate Flotation Fine Coal Cleaning Process (DeMaris, Harvey, Hughes, Miner, and Warren). Petrographic examination of feed coal, coal product, and refuse from the aggregate flotation process provides data on the changes in size and maceral associations of pyrite grains during the process. Observational data are useful in evaluating the physical aspects of the cleaning process. To make the observations, the casting size of samples was enlarged; 150 finely ground, casted samples were analyzed under the microscope for their pyrite size and maceral association, and 15 maceral analyses were made. The pyrite cleanability index (PCI), calculated from the size and association data, was found to be dependent on the fineness of the feed sample and fluctuated with varying flotation conditions. Standardized grinding and flotation conditions were developed to enable direct comparison of petrographic and chemical results between samples.

Results to date from continuous flotation tests show low PCI values for samples taken during the early stages of the tests, but higher values in the coal product during the later stages indicate there is still pyritic material present that could be removed. This suggested that operating conditions for the test needed to be modified during the later stages of the flotation process.

Cooperative Reagent Study with SIU (Camp, Read, Ruch, Meyers of SIU, and FitzPatrick of NU). As part of an ongoing CRSC contract on improving fine-coal cleaning via Aggregate Flotation (AF), the ISGS is systematically testing new reagents in an effort to improve efficiency. C. Meyers of SIU has received a coal industry contract to synthesize specific compounds for possible application as surfactants in coal cleaning. These are composed of a family of dialkylethenesulfonates, which will be tested on very fine coal; Joseph FitzPatrick of NU, using froth flotation, will test the compounds on intermediate size coal.

Previous results from the AF process indicate some preference for using anionic surfactants in flotation of ultrafine coal (-200 mesh). A type of newly developed reagent, a cis - 1,2 -dialkylethene sulfonate, was reported to have rejected 66 percent of pyritic sulfur and 34 percent of the ash. The yield was approximately 70 percent of the combustibles during a simple one-stage flotation test. Results from two-stage flotation increased the combustible recovery to 87 percent. Ash and pyrite were reduced to 6.5 percent and 0.9 percent, respectively.

Efforts are currently underway to synthesize or obtain and test other commercially produced surfactants in a reproducible series of standard flotation tests--batch and continuous.

Inland Steel Project (Rapp, DeMaris, and FitzPatrick of NU). The Illinois State Geological Survey, Northwestern University, and Inland Steel Company are currently involved in a joint research project working to produce compliance steam coal from one of Inland's mines. To reach this goal, a pyritic sulfur rejection level of up to 90 percent must be reached. The Survey's role in this project is to evaluate the use of aggregate flotation and ancillary processes as methods to reach the desired goal.

In mid-December, two survey employees (Philip DeMaris and Dave Rapp) visited the Inland mine to assist in the processing of 24 barrels of coal samples from the mine and mill (8 ROM, 8 Met, 8 steam). Two barrels of this coal were taken to the ISGS Applied Lab where a systematic processing procedure commenced. Sieve testing and table testing have been completed.

Early results have been encouraging, indicating that tabling of a 100 percent minus 6 mesh feed yields a product with 93% BTU recovery, 0.48 percent pyritic sulfur, 1.00 percent total sulfur, and 7.9 percent ash. This corresponds to pyrite and ash rejection levels at 48 percent and 74 percent respectively in the pretreatment stage prior to aggregate flotation.

Ultrafine Coal-Cleaning Via Explosive Shattering and Aggregate Flotation Processes (Ruch, Read, Rapp, Ehrlinger, and Kruse). Preliminary development work, funded by the Coal Industrial Committee, is underway on an Illinois No. 6 seam coal to evaluate a coal-cleaning approach that combines rapid thermal-chemical comminution with efficient physical cleaning. The aggregate flotation process (AF) developed at ISGS will be adopted to treat the product from an 'explosive shattering' process (ES) developed by IITRI. The ES process involves rapid high pressure and high temperature treatment of a coal slurry followed by very rapid adiabatic expansions. This produces an explosive effect that selectively breaks the macerals into very small particles ($\sim 2\mu$) and effectively frees the unshattered minerals. The AF process involves flotation of fine-sized coal via stage addition of surfactants and kerosene to form and float coal-air bubble aggregates, preferentially leaving ash and pyrite in suspension. The combined, sequential use of these techniques, if successful, could significantly reduce the sulfur (both organic and pyritic) and ash content. The ash levels would also be reduced considerably.

Desulfurization of Illinois Coal Using Carbon Monoxide and Ethanol (Shiley, Webster, Hughes, P. Fox, J. Fox, Redding, and Warren of ISGS; C. C. Hinckley and G. V. Smith of SIU-C). Precombustion desulfurization of coal has a high priority in the research programs administered by the Center for Research on Sulfur in Coal. A high proportion of the sulfur in Illinos coal is in the organic form and cannot be removed by physical

beneficiation methods alone. A thermal or chemical desulfurization method will be required in addition to physical beneficiation to produce a compliance fuel from Illinois coals.

"Carbon Monoxide-Ethanol Desulfurization of Illinois Coal"--a precombustion coal-desulfurization method--is currently under development at the ISGS; it uses carbon monoxide and ethanol and yields a low-sulfur, solid product that can be burned in existing power plants. A three-reaction, pyrolytic-desulfurization process has been designed to take advantage of the catalytic properties of an iron sulfide (troilite) that has been found to be the only iron-sulfur mineral to catalytically remove stable thiophenic sulfur (organic) forms from coal.

The three basic steps or reactions in this sequence are (1) reduction of pyrite and marcasite in coal by carbon monoxide to troilite; (2) conversion and removal of organic sulfur catalytically with ethanol over troilite; and (3) removal of the spent iron sulfide catalyst--probably by magnetic separation.

Laboratory experiments on nine coals collected throughout Illinois have shown that the sulfur content can be reduced to federal compliance levels of less than 1.2 pounds of sulfur dioxide per million BTU and 90 percent reduction in sulfur based on run-of-mine coal. For a typical Illinois coal, which ranges from 11,000 to 14,000 BTU/pound, the reduction of sulfur dioxide emissions to 1.2 lbs SO_2/million BTU requires that sulfur concentrations be reduced to 0.55 to 0.7 percent by weight. In order to comply with the 90-percent reduction requirement, sulfur concentrations of 0.3 to 0.5 percent will be required if no other desulfurization strategies are used. As shown in the table, the sulfur levels produced in these products are well within the compliance range. If successfully developed, this process would provide a market for two important natural resources in Illinois: coal and corn. Preliminary calculations indicate that up to 15 percent of the annual Illinois corn production could be used as ethanol for coal desulfurization.

Combustion Properties of Char (Kruse, Rostam-Abadi, Johnson, Kohlenberger, and Buckentin). Char is frequently the product of thermal desulfurization, from precombustion coal-desulfurization methods.

Developing a database on char combustion is essential to ensure that serious market development can commence without delay upon completion of the research underway (i.e., research to produce a low volatile, solid, compliance fuel at a price competitive with low sulfur coal).

A number of ISGS groups cooperated in 1985 to characterize one sample of char. It was from two barrels produced in a rotary kiln at the Process Research and Test Center of the Allis Chalmers Corporation (AC) in Oak Creek, Wisconsin. The feed coal was an Illinois No. 6 coal with 8 to 9 percent ash and 1.95 percent sulfur of which 1.14 percent was organic sulfur; its FSI was 4.5.

The resulting char had 8.8 percent volatile matter, 14.3 percent ash, 1.48 percent sulfur, and a heating value of 12,545 BTU/lb. Its surface area was 8.1 and 307 sq m/g for nitrogen and carbon dioxide, respectively. X-ray examination showed that all pyrite and marcasite were converted to pyrrhotite of about 48.3 atomic percent iron. Quartz and kaolinite were still present. The char was only slightly more difficult to grind than coals currently under study. (Hardgrove Grindability Index: 53.2±0.5). Attempts to remove portions of the mineral matter by three coal cleaning methods (aggregate flotation, froth flotation, and oil agglomeration) were uniformly unsuccessful.

Thermogravimetry (TG) was used to obtain the oxidation reactivity of the AC char in air at 700°C. The data were compared with data for chars of four commercially significant coals reported by Combustion Engineering, Inc. (CE). The CE data included a char from an Illinois No. 6 coal which burned to completion in 0.6 sec at 1454°C. This rate was considered acceptable for burning the char in a commercial utility burner. Because the TG combustion data on the Allis Chalmers char generated at the ISGS compared favorably with that of CE for Illinois No. 6 coal, the AC char should also be acceptable provided the sulfur emissions were reduced. Small-scale tests showed the sulfur content of the AC char was lowered from 1.38 to 0.37 percent by hydrotreating at 800°C for two hours.

DESULFURIZATION OF ILLINOIS BASIN COALS (progress for calendar year 1985)

Coal[a]		Coal % pyrite S	Coal % organic S	Coal % total S[b]	% Organic Sulfur in Product Date Obtained 1/85	5/85	7/85	9/85
West Central	6	1.18	2.71	4.21	0.60	0.60	0.60	0.20
West Central[c]	6	1.21	2.89	4.37	1.01	0.42	0.42	0.15
South Western	6	1.37	2.08	3.56	0.86	0.45	0.20	0.20
South Western	6	0.63	1.79	2.50	--	0.47	0.20	0.20
South Western	5	1.21	2.11	3.47	--	0.52	0.58	0.14
South Central	6	0.38	0.50	0.89	0.37	0.37	0.37	0.05
South Central	6	2.39	1.23	3.91	--	--	--	0.11
South Eastern[c]	5	1.41	1.71	3.15	0.66	0.66	0.66	0.14
South Eastern	5	3.91	1.25	5.36	--	0.78	0.78	0.16

[a] No. 5 is the Springfield Coal Member, and No. 6 is the Herrin Coal Member. The samples were collected as fresh material at the mine and stored under an argon atmosphere. They are not necessarily representative of the mine product.

[b] Total sulfur includes unlisted sulfur present as sulfate.

[c] Preparation plant samples.

Charring Program (Kruse, Rostam-Abadi, Stephenson, Mirza, Moran, and Williams). The objective of ISGS charring research is to develop pyrolysis technology for application to Illinois Basin coals to produce multiphase products, (i.e., synthetic crude suitable for petroleum refiners and low sulfur char for a compliance solid fuel).

The primary focus of the continuing research has been the use of oil shale as a diluent for agglomeration control and as a sulfur scavenger for circumventing the back-reaction of hydrogen sulfide during the hydrodesulfurization of char. The development of a charring process has been approached from several independent angles. First, an extensive literature review was conducted on char desulfurization. It was concluded that the most promising method to produce a compliance-level char is hydrodesulfurization provided the back-reaction can be handled in a cost-effective manner. It was then decided that carbonate-bearing oil shales would be used to prevent the back-reaction by scavenging gaseous hydrogen sulfide.

A thermodynamic study followed, demonstrating the thermodynamic feasibility of using carbonate minerals as sulfur acceptors at various process conditions. Another study showed that an acceptor-based hydrodesulfurization process would be economically feasible under a scenario of increasing oil prices. Such a scenario is the consensus view for the 1990s. Still another study is underway to model the various process steps using the ASPEN computer process simulator.

Experiments have demonstrated that oil shale can be used to reduce agglomeration of coal. Generally, three to five parts shale to one part coal are necessary to sufficiently reduce agglomeration to allow fluidized-bed processing. It has also been shown that an increasing ratio of carbonate-bearing oil shale to coal significantly increases the capture of hydrogen sulfide. A separate but related study demonstrated that small amounts of oxygen either before or after pyrolysis can increase the extent of desulfurization. This study showed that post-oxidation was more effective than pre-oxidation, although more carbon loss occurred during the higher temperatures of the post-oxidation. Since oxidiative pretreatment may increase the rate of hydrodesulfurization, it may be considered as a process step. Experiments are now underway to evaluate hydrodesulfurization kinetics using a 1-inch FBR.

Integrated Study of the Chemical and Mineralogical Behavior of Sulfur in Coal During Pyrolytic and Oxidative Desulfurization (Liu, Hackley, Hawk, and Coleman). The principal objective of this CRSC-funded research during the past year has been the optimization of conditions for maximum removal of sulfur during pyrolysis of coal and post-pyrolysis desulfurization of char. The project has integrated the stable isotope tracing method, a pH monitoring technique, and X-ray diffraction to monitor the behavior of sulfur during pyrolytic and oxidative desulfurization.

Our results show that the maximum pyrolysis temperature is the most important factor controlling the amount of sulfur that can be removed during thermal treatment. The temperature of pyrolysis must be at or

above 550°C to produce chars with the lowest sulfur content in the minimum time. Other parameters such as heating rate, particle size, and soak time appear to be minor contributing factors for total sulfur removal; however, heating rate does directly effect the rate of sulfur evolution during pyrolysis. Furthermore, the heating rate and the particle size both have an effect on the pore structure of the chars, an important factor in post pyrolysis oxidation.

Post-pyrolysis oxidation must be carried out at temperatures below 550°C to produce maximum sulfur removal with minimum carbon loss. The optimum oxygen concentration for removal of pyritic sulfur by post-pyrolysis oxidation appears to be about 5 percent by volume.

One phase of the work resulted in the discovery of a method that effectively converts coal pyrite into a magnetic form of pyrrhotite. The controlling parameters for the conversion are oxygen concentration and temperature. The conversion of pyrite to magnetic pyrrhotite has been successfully tested on several coals at the bench scale. A quick and crude magnetic separation with a hand magnet showed that the sulfur content of the char can be significantly reduced. The sulfur content of an Illinois No. 6 coal was first reduced from 3.76 to 2.5 percent by the pyrolysis, then further reduced to only 1.2 percent by magnetic separation of the char. These are extremely encouraging results, which may lead to more efficient methods for coal desulfurization.

Magnetic Separation and Other Coordinated Engineering Work (Stephenson, Ehrlinger, and Rostam-Abadi). Chemical and minerals engineering expertise has steadily developed. It is now being directed toward upgrading several bench-scale research projects to feasibility status, and to help in process development, e.g., those in fluidized bed reactors and those related to solid-state separations, as for example, when sulfur is converted to a magnetic form of iron sulfide.

Coleman, et al. have discovered that iron sulfides are converted to their highly magnetic monoclinic form by slight oxidation at 550°C following pyrolysis. This step has been duplicated in a 2-inch fluidized-bed reactor (FBR) as part of a preliminary larger scale effort that will include magnetic separation tests.

Pretreatment of Coal to Improve Pyrolysis Performance (Kruse, Ehrlinger, Ruch, Stephenson, Kohlenberger, Rostam-Abadi, Cooper, Chaven, Shiley, and Dickerson). The goal of this project funded by EPRI, is to develop pretreatment methods, which when applied to coal before pyrolysis (charring), will increase the yield and/or quality of the tar produced. A successful pretreatment method may also be applicable to gasification and liquefaction processes. Coal tar from a Wellman-Galusha gasifier was chosen as the baseline tar against which to measure success in increasing quality. Tar from this gasifier has been shown by EPRI to have better than average quality. Black, Sivalls and Bryson was contracted to process 40 tons of fresh River King Illinois No. 6 coal in the Bureau of Mines gasifier located in Minneapolis, Minnesota. Five gallons of tar and two barrels of the feed coal became available to the ISGS in July.

The work to date at the ISGS has been chiefly the acquisition, installation, and testing of equipment. These include a Parr Reactor, a high-temperature sand bath, a small batch reactor, a modified walk-in hood, and a hoist assembly for quick, remote transfer of reaction vessels into and out of the sand bath. Alarm meters for hydrogen sulfide and carbon monoxide were acquired and calibrated. Also, a series of pre-treatment scoping tests screening a variety of agents have begun. The first tests were with coal slurries containing NaOH/KOH in water or ethanol. After treatment, gross effects on tar yield are being determined by the Fischer Assay method.

Enhancement of SO_2 Sorption Capacity of Lime (Rostam-Abadi, Moran, Frost, and Harvey). Because of their high calcium content and their low cost, naturally occuring limestones are commonly used as scavengers to remove sulfur dioxide from combustion gases. However, only 10 to 80 percent of the calcium is normally converted to calcium sulfate. To minimize the amount of limestone needed and also to reduce the amount of waste solid to be disposed of, cost effective methods should be studied for improving the utilization efficiency of limestone to remove sulfur dioxide from burning coal.

The Coal Industrial Committee (CIC) approved funding for an ISGS research contract to investigate the feasibility of improving sulfur dioxide sorption capacity of lime via a physical-chemical method. In this process lime is hydrated under supercritical conditions of water and then subjected to an adiabatic expansion (Explosive Shattering, ES). Facilities at IITRI are being used for this phase of the research in the ES process submicron range particles of pressure-hydrated lime are produced which, because of their high surface area, these particles are particularly effective in reacting with sulfur dioxide. Equipment and samples for this project are currently being assembled to permit the collection of fundamental and engineering data on the physical properties, sulfation capacity, and reactivity of lime, pressure-hydrated lime and pressure-hydrated lime produced by ES processes.

Rates of Microbial Removal of Organic and Inorganic Sulfur from Illinois Coals and Coal Chars (Risatti and Miller). A study has been started to establish the viability of using bacteria to remove sulfur from coal chars and to investigate the reported ability of the bacterium Sulfolobus acidocaldarius to alter organic sulfur compounds and to remove organic sulfur from <200-mesh coals. The influence of temperature, particle size, pulp density, pH, and incubation temperature on the rate of desulfurization are being determined for various types of Illinois coal chars and for an Illinois No. 6 coal. To date, experiments have concentrated on pyrite, troilite, and pyrrhotite minerals and the degradation of dibenzothiophene, an organic sulfur compound known to exist in coal.

Sulfur Removal from Illinois Coals by Rapid Heating in Presence of Different Gases: Use of Microwave Energy (R. Varma of Argonne National Laboratory, D. Buchanan of Eastern Illinois University, C. C. Hinckley of Southern Illinois University at Carbondale, and Shiley and Webster of

ISGS). A gas-flow reactor is being used to heat Illinois coals rapidly to 250 to 300°C (just below their thermal decomposition temperature) in the presence of CO, H_2O, H_2, aliphatic alcohols (CH_3OH, C_2H_5OH, etc.) and mixtures thereof. In preliminary experiments, a 600W microwave reactor at the Argonne National Laboratory is being used as a means of supplying energy to absorbing species present in the gas stream and to components (particularly pyrites) in the coal. This treatment also contributes to rapid bulk heating.

The microwave reactor is being applied to the three-step pyrolytic desulfurization process (Desulfurization of Illinois Coal Using Carbon Monoxide and Ethanol) under development at the ISGS.

Removal of Organic Sulfur from Illinois Coal by Electronic Oxidation (Demir, C.-L. Chou, and M.-I. Chou). Despite extensive research over the past 15 years, a viable method to remove organic sulfur from coal still remains elusive. A research proposal to remove organic sulfur from Illinois coal using a new approach has been submitted to the U.S. Department of Energy. Much organic sulfur may be associated with functional groups and may therefore be removable at relatively low tempertures by reaction with excited oxygen species. Experiments to explore such reactions are planned using low-temperature ashers normally used for isolating unaltered mineral matter from coal.

Illinois Basin Coal Sample Program (Kruse, Rapp, Cooper, and Ruch). A fifth sample, a 3-ton channel sample collected by Argonne National Laboratory (ANL), has recently been added to the Illinois Basin Coal Sample Program (IBCSP). The program is designed to provide uniform

Geologist filling barrels with samples of coal in an underground mine in southwestern Illinois.

samples of coal to researchers to facilitate comparisons of results among laboratories conducting basic and applied research on Illinois coal. This latest sample is of higher quality than the first four because it was maintained in an argon atmosphere from the mine to the processing facility. All additional processing was carried out in ANL's inert atmosphere facility designed for the Premium Coal Sample Program (PCSP) funded by the U.S. Department of Energy. The sample is now available in 5 gallon pails, 1-gallon cans, and 1-pound cans.

A new barrel storage facility has been constructed within the ISGS Applied Research Laboratory (ARL) for storage of the IBCSP coal samples.

OIL AND GAS

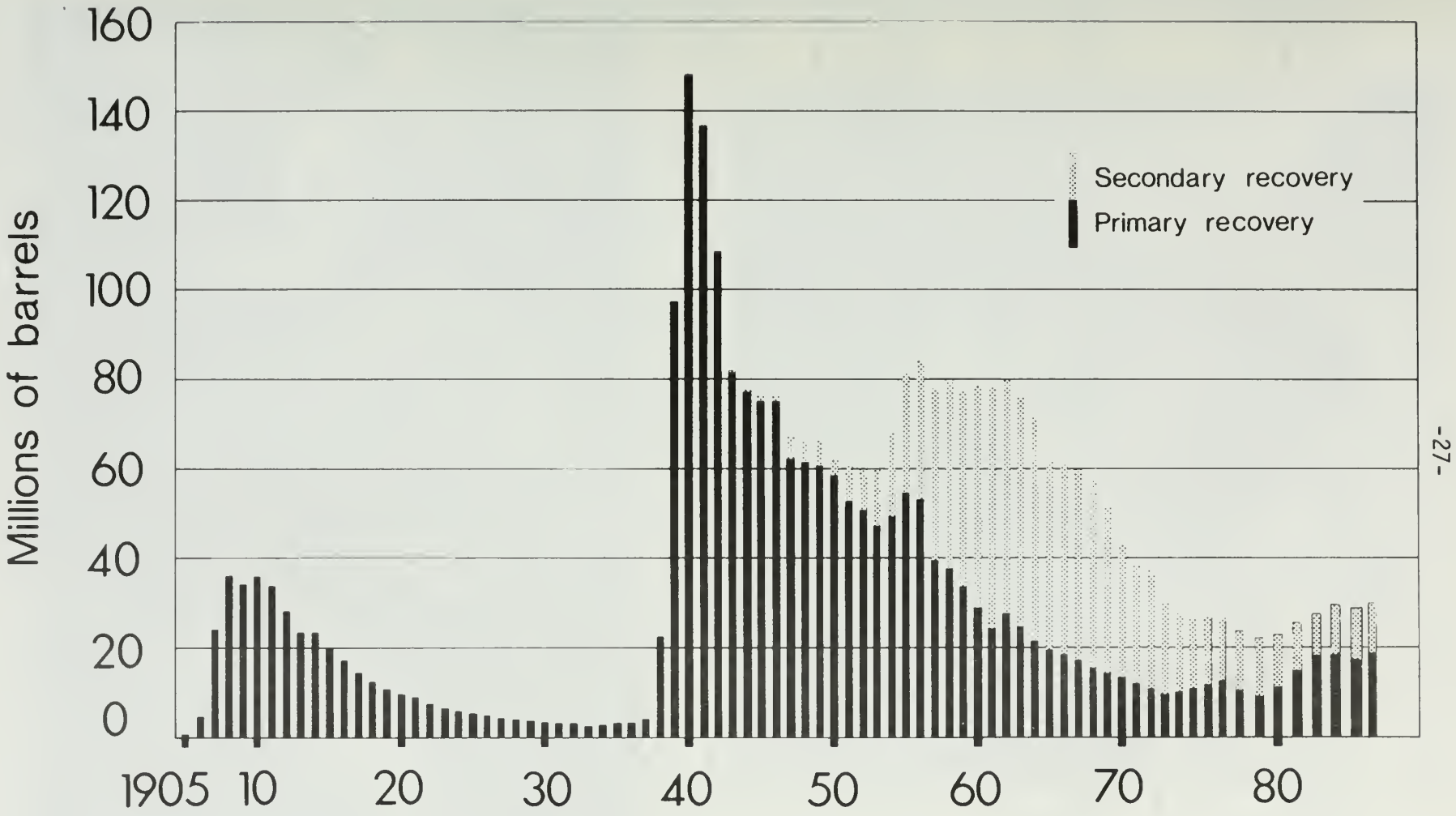
Economic Trends and Outlook

Crude oil production in Illinois in 1985 was 30,264,711 barrels, 4.8 percent more than in 1984. A tabulation of the number of holes reported drilled by the oil and gas industry in 1984 and 1985 follows:

	1985	1984
Oil and gas tests		
New holes	2,260	2,732
Old holes drilled deeper	16	28
Service wells		
New holes	12	102
Old holes drilled deeper	0	0

The 2,260 new holes drilled in 1985 resulted in 1,347 oil wells, 47 gas wells, and 866 dry holes. Illinois ranked eighth in the United States in total wells drilled in 1985, and sixteenth in total oil production. The following 12 counties accounted for 68 percent of the reported new holes drilled.

County	Number of holes	Percent of State totals
Crawford	242	10.7
White	230	10.1
Wayne	203	9.0
Clay	154	6.8
Edwards	131	5.8
Jasper	131	5.8
Lawrence	92	4.1
Clark	76	3.3
Saline	75	3.3
Richland	69	3.0
Wabash	67	2.9
Christian	66	2.9
	1,536	67.7


Millions of barrels
160
140
120
100
80
60
40
20
0
1905
10
20
30
40
50
60
70
80
Secondary recovery
Primary recovery

In 1985 discoveries reported included 2 oil fields, 3 gas fields 43 new pay zones in existing fields, and 52 extensions to the fields; the new fields are all small. Main Consolidated Field in Crawford, Lawrence, and Jasper Counties ranked fourteenth of all heavily drilled fields in the United States. Clay City Consolidated in Clay, Wayne, and Jasper Counties ranked fifteenth.

Oil and Gas Program for Illinois

The Survey's Oil and Gas Program encourages the petroleum industry to explore and develop resources in Illinois by providing the comprehensive data collection, mapping, and stratigraphic research required to generate new petroleum targets, new techniques for exploiting existing fields and plays, and new research directed toward improving oil recovery from Illinois reserviors.

The Geological Records Unit constructs, expands, and computer enhances the Survey geological database. Achieving this goal depends on communication between Survey geologists and the petroleum industry, which provides the Survey with well records, drill cuttings, diamond cores, crude oil and gas samples, seismic data, and other information pertinent to the search for hydrocarbons in Illinois.

Oil and gas data are made available to the public via (1) an annual report on the petroleum industry in Illinois; (2) a monthly drilling report; (3) oil and gas pay zone maps (showing the geographical area underlain by oil production from individual rock layers); and (4) maps showing the subsurface depths of selected strata.

Survey scientists in turn use the geological database to study and interpret the geologic and geochemical phenomena controlling petroleum generation, migration, and accumulation in Illinois. The findings are presented to the public through Survey publications and other journals, talks to interested groups, and conversations with individuals visiting or calling the Survey. This interaction of people and ideas sparks new interest and insight into Illinois' hydrocarbon potential, which is economically important to all its citizens.

Petroleum Geology Investigations

Reservoir Research (Oltz and Seyler). Illinois reservoirs may retain over half the discovered oil during routine producing operations. To improve oil recovery, a major study of the chemical and physical characteristics of Illinois-specific reservoirs has been initiated. A screening profile including scanning electron microphotographs and X-ray diffraction analyses of seven Illinois reservoirs showed significant differences between them, especially in clay content, types of clay minerals networks, and cementing minerals. These differences may contribute to differences in well productivity and influence completion practices.

Scanning electron microscope photograph of "bridges" formed of clay minerals between sand grains in an Illinois petroleum reservoir. They can obstruct the flow of oil and decrease production.

A scanning electron microscope shows greatly magnified sand particles in an Illinois petroleum reservoir. These sand grains are coated with minerals such as chlorite and calcite that may stop oil production—if not properly treated. The dark black area is a pore through which oil normally flows.

Petroleum Geology of Lower Chesterian Sandstones in the Illinois Basin (Seyler). Research on stratigraphic traps in the sandstones and limestones of the Aux Vases Formation is designed to encourage petroleum exploration in Illinois by increasing understanding of the deposition and distribution of an important reservior rock and providing a model to predict the location of reserviors.

Our research has shown that stratigrapic traps in the Aux Vases are complex and consequently poorly understood. They are dependent on lateral changes in grain size and thickness of the unit. To delineate areas with the greatest potential for future production, the Survey has initiated studies of electric logs cores, and outcrops.

Reservoir Characteristics of the Aux Vases Formation in Illinois (Seyler). The reservoir characteristics in the Aux Vases Formation, especially the clay mineral content, contribute to the causes of poor well completions and rapid declines in oil production from the Aux Vases. Petrophysical results from X-ray diffraction and scanning electron microscopy (SEM) analysis should prove helpful in designing, and can be used to improve completion practices and increase production from the Aux Vases Sandstone.

Core Workshop and Field Trip Featuring Aux Vases and Ste. Genevieve Formations (Seyler and Crockett). A core workshop and field trip guidebook were prepared highlighting exploration models and completion practices that may lead to improved oil recovery from the Aux Vases and Ste. Genevieve Formations.

Beverly Seyler (second from right), Oil and Gas Section and President of Illinois Geological Society, organized the field trip.

Shallow Petroleum Occurrences in West-Central Illinois (Seyler and Crockett). A 2-year exploratory effort of nationwide interest has focused on Silurian oil accumulations 450 to 650 feet deep in the area east of Quincy. Demand for a plausible exploration model was noted. Data necessary for developing such a model--including cores, drill cuttings, and gamma neutron logs--have been acquired during the past year. Analyses of these data is continuing.

Atlas of Petroleum Geology in Illinois (Crockett, Howard, Seyler and Whitaker). Additional field studies have been undertaken in the Yale Consolidated, Germantown East and Hardinville area in Main Consolidated fields, which will be included in a compendium on petroleum geology in Illinois to be completed at the end of the decade.

A Paleoecological Model for the Development and Distribution of Silurian Pinnacle Reefs for Hydrocarbon Exploration (Whitaker, Mikulic and Oltz). The geological features of known Silurian reefs are being studied to better understand how they developed and where new reefs might be located. Work to date has concentrated on the best exposed reefs in the state--those in the Chicago area. This study will present the most likely trends for the development of reefs and some methods for mapping undrilled reefs in an attempt to encourage exploration for these features, which have long been of economic importance in Illinois. Approximately 80,000,000 barrels of oil have been produced from Silurian reefs and reef-related structures in Illinois. Unfortunately, known reserves of this resource are rapidly being depleted and no new reefs have been located in recent years.

Statewide Grid of Surface-to-Basement Lithologic Cross Sections (Seyler, Jacobson, Howard, and others). Work continues on a network of six north-south and eight east-west lithologic cross sections. Data for these sections are coming from well logs and drill cuttings. Some industry-acquired proprietary seismic data has become available for coordination with and extrapolation of our well data. The cross sections should provide information on the state's deep frontier, a sequence of sedimentary rocks up to 2 miles thick underlying a mile-thick section within which successful oil exploration has occurred. The little that is known of petroleum potential of these deep rocks has come from a few deep tests and current Survey petroleum source-rock research sponsored by several major oil companies. Greater knowledge of the deep subsurface conditions may lead to the generation of new, deeper "play" concepts--incentives for industry to participate in exploring the deep basin. Two north-south sections are ready for drafting.

Hydrocarbon Accumulation in Basal Pennsylvanian Fluvial Sands (Howard and Whitaker). Over 6 percent of Illinois Basin oil production has come from basal Pennsylvanian sands in paleovalleys at the Mississippian-Pennsylvanian unconformity. However, published documentation of the petroleum geology of hydrocarbon accumulations in these strata is scanty. The first report on their occurrence in Illinois is in press: "Hydrocarbon Accumulation in Basal Pennsylvanian Fluvial Sand Bar, Hardinville area, Crawford County, Illinois".

A general lack of recognition of the hydrocarbon potential of basal Pennsylvanian traps has lead to their common omission as exploration targets. The Hardinville accumulation mentioned above was penetrated, unrecognized, and 2 years later discovered fortuitously.

An effort has begun to increase awareness of the petroleum possibilities of the basal Pennsylvanian within the Illinois Basin. An early step in this direction is the revision and planned re-issuance of a basinwide color map, plate 1 of ISGS Circular 458, showing the distribution of paleovalleys in which basal Pennsylvanian sands were deposited.

Computer-Generated Maps (Crockett and Treworgy). A series of computer generated structure contour and isopachous maps for a Brown County township were generated. These maps were used to evaluate various mapping software packages available to the Survey. Intrepretations of the geologic implications and evaluation of the software are in progress. Evaluation of computer mapping packages has focused on the Surface (II) package using the Prime 750 and the CONTUR software package using an IBM AT personal computer.

Pool Studies (Crockett and Seyler). Pool studies on a number of oil fields in Illinois were compiled by the Oil and Gas Section: Jasper County--Hunt City East, Hunt City South, and Yale Fields; Franklin County--Bessie Field; Brown County--Buckhorn Consolidated Field, Siloam Field; Schuyler County--Brooklyn Field; Adams County--Kellerville Field; McDonough County--Colmar-Plymouth and Brooklyn North Fields.

Occurrence and Maturation of Sedimentary Organic Matter in the Illinois Basin (Barrows, Damberger, Harvey, Oltz, et al.). This study, sponsored by nine major oil companies, analyzes the entire Paleozoic sedimentary sequence of the Illinois Basin to determine the nature and maturity of dispersed organic material in the sediments. The final report should be released by mid-1986. This study has delineated major source rocks for hydrocarbons and their degree of maturation throughout the Illinois Basin.

Seismic Acquisition, 1986 (Oltz). In 1985-86, two major oil companies and two independents agreed to make selected Illinois seismic lines available to the Survey for scientific use.

Source Rock and Migration Studies

Organic Geochemistry of Illinois Basin Crude Oils (Risatti, Dickerson, and Oltz with J. Hatch, Oil and Gas Division, United States Geological Survey, Denver) The organic geochemistry of Silurian and Ordovician oils from the Illinois Basin is being investigated. The major goals of the study are to provide basic knowledge of petroleum biomarkers as indicators of oil migration and maturation as well as to characterize Illinois Basin petroleums for source rock-crude oil correlations.

Organic Geochemical Study of the Source Rocks and Petroleum in the Illinois Basin (M. M. Chou and Dickerson). Preliminary studies indicate that sufficient organic matter has been preserved within some of the beds of the New Albany Shale Group for hydrocarbon generation and subsequent expulsion to have occurred in southeastern Illinois. The results also show that some beds of Ordovician age are organic rich and sufficiently mature to have generated hydrocarbons.

The chemical "fingerprint" of the extractable alphatic hydrocarbons of a shale sample from the Ordovician Guttenberg Formation is comparable to the aliphatic hydrocarbon composition of Ordovician crude oils. They both contain a low concentration of pristane and phytane and higher molecular weight (>C19) normal alkanes. As more evidence is acquired, the correlation observed in this preliminary study will be further defined. For example, more geochemical parameters, such as characterization of biomarkers, composition of pyrolysis products, and isotopes (carbon and sulfur) will be performed in the future on both rock extracts and crude oil samples to aid in source rock evaluation and correlation to known oil reservoirs.

Composition of Natural Gas

Flow Testing of Oil and Gas Wells (Riley). Within the past year, 23 gas and gas/oil wells were tested to determine gas-flow rates; these analyses help operators determine the commercial feasibility of producing from the wells and provide a database for analysis of future gas finds. This testing service is the only one of its kind in the state, apart from in-house testing by major companies of their own wells. As a result of the ISGS testing and consultation, natural gas that would have been flared or shut-in is now being used. Of interest in 1985 is a new gas field in Macoupin County, near the town of Plainview. Nine wells have been tested in the area. The Prentice Gas Field in Morgan County was tested by this laboratory last year; it is now producing gas online.

Chemical and Isotopic Composition of Natural Gas (Riley and Coleman). Samples of natural gas are analyzed quantitatively to determine composition, specific gravity, and Btu value. Isotopic analyses are performed on certain samples. Thirty-eight samples were collected in the field as part of the gas-flow testing service. An additional 35 samples were submitted by gas producers, land owners, the Illinois Commerce Commission, and Survey staff engaged in research. The information gained from these analyses adds to the ISGS database and aids in distinguishing natural gases from different sources.

Urban encroachment has ended expansion of this 100-year-old quarry site near Joliet in Will County, Illinois.

INDUSTRIAL MINERALS AND METALS

Limestone and Dolomite

Urban Encroachment on Dolomite Resources of the Chicago Area (Mikulic). Dolomite rocks are the main source of construction aggregate in the Chicago area. As reserves of these rocks become depleted and urban sprawl encroaches on potential quarry sites, the search for new sources of crushed stone becomes urgent. The goal of this study is to set guidelines to ensure continued production of low-cost, high-quality stone in the Chicago area. Attention is being directed to the possi-

bility of locating new quarry sites and towards the development of underground mining in the area. Work to date has been largely restricted to an examination of the subsurface records and study of present quarries to determine the quality of individual rock units. It has also included a search for undeveloped sites and the determination of their potential. The comprehensive subsurface (drill core) holdings of the Metropolitan Sanitary District of Greater Chicago will be examined as part of this project.

Susceptibility of Selected Carbonate-Rock Aggregates to "D-cracking" (Baxter, Bauer, Hughes, Harvey, Masters et al.). A new cooperative research project with IDOT's Bureau of Materials and Physical Research involves the evaluation of Portland cement-grade limestone and dolomite aggregates. IDOT has found that its new freeze-thaw test for quality assurance is not only too time consuming to accurately monitor quarry production, but contrary to the initial round of uniformly low expansion values for most limestone and dolomite aggregates. Continued testing is giving non-uniform, often higher than acceptable expansion values for many limestone sources. ISGS researchers will be conducting various investigations into the physical and mineralogical properties of the 12 selected aggregates, to seek a simple test for aggregate evaluation. This project will contribute to IDOT's ability to evaluate the suitability of coarse aggregates for use in Portland cement highways, which will provide a safer, more durable road system.

Water Proofing of Limestone Dust (Khan and Baxter). Coal dust should be diluted in order to reduce the danger of coal dust explosion. Dilution with incombustible stone dust will make coal dust incapable of propagating an explosion. Coal dust is hydrophobic and remains dispersible for long periods of time after generation and deposition in the mines; whereas the stone dust loses its dispersibility in humid air, cannot dilute the coal dust at the time of explosion, and becomes ineffective. To investigate the ability of surfactants to waterproof stone dust, an apparatus that allows one to determine the dispersibility of stone dust was constructed at ISGS. Because of its portable nature, the apparatus could be adapted for use in underground mines to check the condition of stone dust.

Sand and Gravel

Preliminary Study of Chert from Portland Cement-Grade Gravels: Specific Gravity Distribution Related to Freeze-Thaw Test Expansion (Khan and Masters). Statistical analysis of the freeze-thaw test expansion data on gravel samples studies in the IDOT-ISGS cooperative research project and data from the other IDOT quality-control tests shows that the amount of less than 2.35 specific gravity chert correlates with the expansion data much better than data from other IDOT tests. Research is continuing on the distribution of chert of various specific gravities in the study samples and the relationship between chert distribution and the freeze-thaw test data. If the results of

this study support IDOT data, showing that low specific gravity chert is related to increased freeze-thaw expansion values, it can be used to encourage efforts to find economic ways to remove this material from gravel aggregates, so that the aggregates become suitable for use in future Illinois highways constructed with Portland cement.

Terraces of the Rock River Valley in Southern Wisconsin and Northern Illinois (Anderson, Augustana College; and Masters). Studies were conducted on the geomorphology and sedimentology of terraces in the Rock River Valley between Lake Koshkomong in northern Rock County, Wisconsin, and the mouth of the Kishwaukee River in southern Winnebago County, Illinois. Except for the oldest, highest terrace remnants and a few remnants upstream from Jamesville, Wisconsin, which appear to be bedrock-controlled erosional terraces, the terraces are the result of glacio-fluvial deposition and can be traced upstream to correlative moraines. From oldest (highest) to youngest (lowest), the terraces are the Rockford, Johnstown, Milton, and Lake Mills; these terraces contain Wisconsinan and Illinoian sand and gravel that record a complex history of outwash plain and valley-train deposition. These sand and gravel deposits are important economic sources of construction aggregate: however, the flat, well drained terrace surfaces are attractive sites for industrial, residential, and agricultural use. Such development on the terraces restricts the areas available for sand and gravel extraction.

Fine Sand Mineralogy and Pebble Lithology of Glacial Tills Across South Central Illinois (J. Fox; and W. H. Johnson, University of Illinos). A series of glacial drift sections with known clay mineralogy and Chittick carbonate composition (between St. Louis and Terre Haute) have been sampled for fine-sand mineralogy and pebble lithology. Lithologic boundaries are supported by 3 to 5 mm pebble counts. Fine sand (.25 to .125 mm) mineralogy is being determined by X-ray diffraction.

Mineralogical analysis provides data that permits stratigraphic correlation. Because eastern and northern drift have come from mineralogically distinctive bedrock regions, it is also possible to assess till provenance. Detailed knowledge of the mineral composition of glacial drift offers insight into Pleistocene history, permits resource evaluation of potentially useful deposits that mantle nearly all of Illinois, and provides essential information for land-use planning.

Clay

Comminution of Clay Particles (Khan. Hughes, Berggren, and Baxter). Grinding is one of the most energy- and capital-intensive steps of mineral-processing operation. Considerable savings can be achieved by making this step more effective and efficient. Use of lighter and harder grinding media capable of crushing (disintegrating) proportionately larger quantities of solids in a reasonable time would reduce energy and consumption of media. Plastic beads used in drilling operations were introduced as grinding media for clays in a vibrating grinder at ISGS. The plastic beads gave almost the same grinding efficiencies

as the glass beads that were 2.5 times heavier. This use of plastic beads for comminution of softer materials could result in considerable savings.

Bulk Mineralogy of Illinois Clays and Shales. Computer File of Test Data on Illinois Clays and Shales (Hughes, J. Fox, and Warren). This project is designed to obtain and store useful information on clays and shales, and to provide the information in a readily retrievable form. The information can be used to locate particular types of clay resources, to correlate with engineering properties, and to study changes in composition that result from depositional and post-depositional processes. For the most part, the file allows a rapid response to manufacturers that request a source of suitable clay for bricks, wall tile, flower pots, cement clay, cat litter, or similar products. This file grows by 1,000 to 3,000 samples per year. Storage and retrieval is aided by a microcomputer system.

Kaolin Slurry Production from St. Peter Sandstone Slimes (Khan, Berggren, Hughes, and Cowin). This study is to determine the feasibility of marketing kaolin waste clay as a by-product of silica sand production. The kaolin is present as a minor constituent of the sand, and it could be extracted from the present-day waste streams or from tailings ponds. The research attempts to measure the resource; to determine the response of the clay to grinding, classification, and flotation; to improve the process of dewatering the clay or remove the clay by flotation; and to design an integrated method of producing and marketing the kaolin.

A Periodic Visitation, Sampling, and Consultation with Illinois Clay Producers (Hughes, J. Fox, and Warren). These visits continue as time permits. Raw material samples are usually taken, so that a backlog of compositional data can be used to compare to future times of production difficulties. Visits generally combine with field work.

A Review of the Economic Potential of Illinois Underclays (Hughes and White). A publication under review summarizes the origin and distribution of clays and shales associated with Illinois coals. Our results show that underclays and partings in coals were soils, but most of the soil formation in underclays resulted from plant growth before the establishment of the coal-forming swamp. Some underclays and most shales overlying coals are relatively unaltered deposits of detritus. Underclay composition is probably related to the location of channels, much as low-sulfur coal and nonmarine roof shale are also associated with the channels. The clays may further provide important clues to the origin of pyite and marcasite that form in coal-bearing strata.

Architectural Practices in the Use of Bricks (I. Schousboe and Hughes). Professor Schousboe has made a sabbatical tour of the United States and Australia to survey the problem of moisture expansion of brick. A publication is planned for architects that will outline the range of potential problems associated with brick, explain ways to avoid the pitfalls, and integrate the properties of bricks with the task of designing and constructing lasting structures.

Silica and Industrial Sands

Feasibility of Recovery of Sand and Clays from Sand-Processing Plant Rejects of Northern Illinois (Khan, Bhagwat, and Baxter). The production of silica sand from St. Peter Sandstone amounted to 3.75 million metric tons in 1984. The fines, mainly kaolin and fine-grained silica sand, are rejected into tailings ponds during the processing required to generate marketable sand. A study was undertaken to determine whether the revenue generated from selling the products recovered from the material now being discharged into tailings ponds by an average Illinois sand-processing facility, would be sufficient to justify investment in a secondary processing plant.

The economic viability was tested and proved using the Net Present Value approach to the cash-flow analysis. For a typical sand-processing plant in northern Illinois, the additional investments required would be about $1.3 million (1985). Over a 5-year period. the project of recovering sand and clays from the waste streams would generate between $0.9 and $1.5 million net of all the capital related and operating expenses. Further benefits are expected due to reduction in size or elimination of tailing ponds. The report has been completed and accepted by the American Association of Cost Engineers for presentation at their 30th Annual Meeting in Chicago to be held in June 1986

Feasibility for Recovering Fine-Grained Quartz and Kaolin from Abandoned Sand-Washing Tailings Ponds (Khan, Bhagwat, Baxter, and Berggren). A feasibility study was carried out to determine whether the fine-grained quartz sand and kaolin in the tailings ponds are a recoverable resource. Calculation of proven, probable, and possible reserves of an abandoned tailings pond indicated that the slurry ponds of sand-processing plants contain significant amounts of fine quartz sand and kaolinite, the recovery of which is technically feasible and economically attractive. Feasibility analysis indicates that the venture could be a success under all realistic expectations concerning reserves, equipment prices, and the equipment life. Sampling and testing of materials at one site in northern Illinois indicate substantial tonnages of sand and kaolin. With an initial investment of about $460,000, it would be possible to earn high rates of return on investment. Because the pond sites are generally moderate in size, moving the equipment to another site after completing the operations at the initial site could greatly improve the profitability. Over a period of 5 years the project could generate more net income than the initial investments after discounting. In most scenarios of the analysis, the Net Present Values (NPV) were several times the capital investment (i.e., high investment efficiency). The secondary recovery operation will have a significant positive environmental impact, the benefits of which cannot be easily qualified in monetary terms.

The report has been completed and accepted by the International Powder Institute of London (England) for the Powder and Bulk Solids Conference to be held in Rosemont, Illinois, in May 1986.

Industrial and Metallic Minerals Activities

Midcontinent Strategic and Critical Minerals Program - Phase II (Baxter). The Midcontinent Strategic and Critical Minerals Program (MSCMP) is being carried out by the USGS, in cooperation with 12 midcontinent states, to assess the strategic and critical minerals potential of a large midcontinental area. All of Illinois west of the 88° parallel of longitude is included in the study area. As part of Phase II, ISGS is preparing various maps and cross sections for delivery to the USGS. These deliveries include

- state tectonic map (1:1,000,000)
- isopach (thickness) map of the Mississippian carbonate sequence from the base of the Aux Vases Sandstone to the base of the Valmeyeran or Kinderhookian Limestone (1:1,000,000)
- lithofacies map (limestone/dolomite ratio) of the carbonate sequence (1:1,000,000)
- three east-west cross sections (1:500,000 horizontal and 1:1,200 vertical).

From the data suppied by the states, the USGS will compile and prepare similar maps, at a small scale, for the larger area bounded by latitude 36° and 46° N and by longitude 88° and 100° W. The State tectonic map was delivered during the reporting period; and work on the isopach map, lithofacies map and cross sections continues.

Expanded Mineral Resource Appraisal of Southern Illinois (Eidel, Baxter, and staff). The USGS's Conterminous U.S. Mineral Appraisal Program (CUSMAP) began about 10 years ago for evaluation of regions known to have a high potential for nonfuel mineral resources. Recently the USGS accepted a joint proposal from the Illinois, Missouri, Kentucky, and Indiana Geological Surveys that the Paducah 1° x 2° quadrangle sheet be included in the CUSMAP program begining in U.S. fiscal year 1987. The program will include surface and subsurface geological compilation; major, minor, and trace-element geochemical analysis of existing drill holes; and geophysical compilations at a scale of 1:250,000 (1 inch = about 4 miles). A comprehensive folio of geologic, geochemical, and geophysical information will be compiled allowing an in-depth evaluation of the fluorspar, barite, base metal, beryllium, thorium, rare earth, coal, oil and gas, and industrial mineral potential of southern Illinois.

A planning session and field trip for various state and federal staff to be involved in the Paducah project was held April 15-17, 1986, in southern Illinois and western Kentucky.

Ralph L. Erickson, USGS geologist, and John M. Masters, Industrial Minerals Section, describe insoluble residues from well cuttings and cores. Spectrographic analyses for trace elements are made in the USGS mobile laboratory on site at the ISGS Annex. This pilot study may lead to expanded studies to identify areas favorable for mineral exploration.

Northeastern Illinois contains abundant deposits of coarse gravel—an important source of high-quality construction aggregate. The deposit exposed in this pit is a Wisconsinan outwash plain. John M. Masters, Industrial Minerals Section, holds a 5-foot scale.

Geochemistry of Insoluble Residues from Well Cuttings and Core Samples in Illinois - A Pilot Study (Masters, Baxter, Lowry, and Khan). The first phase of an insoluble residue pilot study being carried out in cooperation with the USGS has been completed. As shown by previous USGS work in Missouri, the distribution of trace amounts of metals in insoluble residues of potential carbonate host rocks can be used to define subsurface exploration potential on a regional scale. To test the method in Illinois, approximately 4,400 samples were prepared from insoluble residues from 29 wells forming a transect extending from the Upper Mississippi Valley Lead-Zinc-District, south along the western edge of the Illinois Basin to southern Illinois, with links to the Illinois-Kentucky fluorspar-zinc-lead-barite district in the deeper portion of the Illinois Basin. A USGS mobile laboratory was set up at the Natural Resources Annex Building for 3 weeks in October, at which time samples were described and analyzed for 31 major and minor elements by emission spectrography. Six hundred additional samples were taken to Denver for analysis. Approximately 1,800 samples remain with the Survey for description prior to a second USGS visit with the mobile lab in April 1986. Although the interpretation of data is in an early stage, anomalous values are apparent that will demand considerable future attention.

Industrial Minerals and Metals (Masters, contributor). The book Natural Resources of Illinois: Introduction and Guide, to be published by the Natural History Survey, will contain a geologic sketch of minerals produced commercially in Illinois including limestone and dolomite, sand and gravel, peat, clay and shale, silica sand, fluorite, and tripoli. Sphalerite (zinc ore) and galena (lead ore) are recovered as by-products of fluorite mining, and are currently the only metals mined in Illinois. This article is intended to give readers sufficient information on the nature of industrial minerals and metals mined in Illinois to recognize the diverse ways in which they occur and their importance in everyday life. Basic references guide readers toward sources with more detailed information.

Air-Floc Flotation: Beneficiation Method for Processing of Ultra Fines (Khan). Mineral beneficiation plants increasingly process finely ground materials generated either as a result either of intensive grinding carried out to liberate embedded impurities or of mechanization of mining operations. Beneficiation of these fines by conventional froth flotation process is difficult and costly. The selectivity and efficiency of separation are adversely affected by coating of larger particles with fines of other materials, by slow settling rates of fines, and by entrapment of fines in the froth.

A new processing method, called Air-Floc Flotation, developed at the ISGS by L. A. Khan, is specifically tailored to take care of some drawbacks of the froth flotation process. This method utilizes the principles of froth flotation but differs from it by use of a pregenerated froth that is mixed with a preconditioned slurry before separation/segregation of product from reject is allowed to take place. The success of this process depends on the proper selection of surfactants to entrap air in micron-size bubbles and to form coatings on air

bubbles capable of selectively collecting the hydrophobic particles. The findings of this research will be presented at the American Chemical Society Meeting Symposium on Surfactants in Mineral and Material Systems.

MINERAL ECONOMICS

Illinois Mineral Industry in 1981-83 and Review of Preliminary Mineral Production Data for 1984 (Samson and Bhagwat). A brief summary of the report published as Illinois Minerals Note 93 has been enhanced with final 1984 data and preliminary 1985 data and is included in the introduction to this Annual Report.

Directory of Illinois Stone, Sand and Gravel Producers 1985 (Samson). The directory, published as Illinois Minerals Note 91, provides names and addresses of mineral producers and has been in great demand in and out of Illinois. The 1986 version in preparation will include names of producers of other minerals as well.

The United States Fluorspar Industry in a Cost/Price Crunch (Bhagwat). This report analyzes the decline of the U.S. fluorspar industry, which is synonymous with Illinois fluorspar industry. Ten factors of national and international significance were statistically analyzed. The results indicated that the decline in fluorspar was strongly correlated with the decline in the steel and aluminum industries of the United States and was exacerbated by the low cost imports from Mexico, South Africa, China, and other countries. The low cost of imports results from high grade ores and low labor costs in foreign countries. The U.S. fluorspar industry revival thus requires simultaneous actions to increase exploration within the United States and to improve the economic conditions in the steel and aluminum industries of the nation.

Impact of a Severance Tax on Illinois Oil Production (Bhagwat). This draft report investigates the cash flows generated by a typical Illinois oil-producing operation. The results indicate that an average Illinois oil well must produce at least 2.5 barrels of oil per day to break even when the oil price is $20 per barrel. The current average production in Illinois is about 2.8 barrels per well per day. A severance tax was found to increase the break-even production level needed more than proportionally. Other factors causing an increase in break even production are well depth, drilling cost increases, and oil price declines.

Importance of the Mineral Industry for Illinois Counties South of the 38th Parallel (Bhagwat). As part of the ISGS mineral resources assessment program south of the 38th parallel, a presentation was made during the annual board meeting in Champaign. It outlined the high unemployment in the area, the concentration of the mineral industry of Illinois south of the 38th parallel, and the jobs provided by the mineral industries. Unemployment in the area is currently more than twice as high as the state average. About 40 percent of the minerals

value of Illinois is generated south of the 38th parallel and the mineral industry provides 11 percent of all jobs in the area. Coal, oil, and fluorspar industries were discussed, their strengths and problems outlined, and the need for geologic mapping stressed.

Analysis of Exploitation Processes (Khan, Bhagwat, and Baxter). To assist operators, the Industrial Minerals and Metals and the Mineral Economic Sections of the ISGS have launched a program of determining the economic feasibility of selected operations. The studies that are expected to be completed this year will cover (1) comparison of alternate flow diagrams for cleaning silica sand; (2) impact of the tonnage of feed on the feasibility of recovery of fine grained quartz sand and kaolinite; and (3) economics of secondary recovery of coal.

Service Activities. Telephone inquiries, letter inquiries, and visitors asking for information accounted for an estimated 10 percent of the staff time. Office conferences with visitors and students seeking information and guidance required up to 5 percent of staff time.

MINERAL RESOURCES

Basin Analysis Task Force

On November 1, 1985, the Basin Analysis Task Force was formed to develop a sound regional framework of the Illinois Basin and synthesize the vast amount of existing data in order to stimulate economic growth and scientific progress. The approach is multidisciplinary, utilizing

Members of the Basin Analysis Task Force discuss map of study area with Sandra K. Stecyk, Publications, Graphics, and Photography Unit, who is art director for the AAPG volume on interior cratonic sag basins. Left to right: Melissa M. Chou, Dennis R. Kolata, Stecyk, Janis D. Treworgy, Michael L. Sargent, and Paul C. Heigold.

geological, geophysical, and geochemical data. The task force is attempting to identify oil and gas plays in close cooperation with the Oil and Gas Section. Comprehensive analysis of the Illinois Basin will identify gaps in scientific research that must be addressed to further the overall knowledge of the Illinois Basin and to improve our predictive ability within the basin.

Interior Cratonic Sag Basin Volume (Leighton and others). The ISGS staff is compiling one of five volumes to appear in the American Association of Petroleum Geologists (AAPG) Petroleum Basin Series. This series is intended to give a broad overview of significant fundamental basin types, their evolution, their oil and gas plays, as well as distribution and size of oil and gas fields. Each fundamental basin type is to be analyzed to determine the significant factors that control the plays and resulting fields.

The Illinois Basin will be the type or model basin in the Interior Cratonic Sag Basin volume. During compilation of the volume, the gaps in our knowledge about the Illinois Basin will become more sharply defined and will provide a focus for further basin analysis.

Paleotectonic Maps for the Illinois Basin and Bordering Areas (Kolata, Sargent, J. Treworgy, and Stephen Marshak, UI-UC). There is a substantial need to integrate and graphically display information on the tectonic evolution of the Illinois Basin and of the midcontinent in general. At present, literature concerning the region is difficult to access and visualize. To solve this problem a series of paleotectonic maps for major periods of deformation are being compiled. Each map will illustrate the distribution of faults, folds, uplifts, and basins for a specific time interval, and thus will provide a means to visualize the patterns of tectonic activity.

Middle Ordovician Guttenberg Formation in the Illinois Basin--Thickness, Distribution and Lithofacies (M. Chou, Kotata, Sargent, and J. Treworgy). Recent studies by the USGS and the ISGS indicate that the shale in the Guttenberg Formation has substantially high total organic-carbon content (as much as 45%; type II kerogen). The organic-carbon content is rich enough to be an excellent source rock. Maps showing the thickness, distribution, and lithofacies are being compiled. An attempt will be made to identify plays based on an analysis of the Guttenberg.

Structure, Topography, and Precambrian Geology in Illinois (Sargent). A map of Precambrian basement has been revised and updated to reflect the most widely held views of this ancient surface. The map is important for seismic risk assessment, COCORP reflection seismic program, Illinois Superdeep Drillhole planning, the AAPG Interior Cratonic Sag Basin volume, and DNAG History of the Illinois Basin.

GEOLOGICAL RECORDS UNIT

The Geological Records Unit is the mandated, legal repository for records of all drilling within Illinois: oil and gas wells, water wells, engineering borings, and miscellaneous test holes. This database is used heavily by the oil industry, coal industry, hydrogeologists, engineers, land-use planners, land owners, the general public, and staff. Additional space to house the rapidly expanding collection is needed.

Collections	1985-86	Total
Processed drillhole records	5,616	266,116
Books of processed drillhole records		749
Skeleton logs (records of wells drilled prior to 1920)		17,950
Skeleton log books		40
Confidential log books		15
Out-of-state log books		14
Miscellaneous hole record books		9
Geophysical logs	4,759	111,658
Coal pluggings	2,116	17,880
Filing numbers - sample sets	562	65,462
Filing numbers - cores	104	13,054

Data Acquisition

Basic Data	1984-85	1985-86
Oil permits	5,013	4,603
Oil permit corrections	672	173
Water permits	5,213	5,831
Plugging affidavits (oil and water)	2,316	2,230
Logs		
Electric logs	1,395	2,028
Micrologs	157	288
Radioactivity logs	1,362	2,006
Miscellaneous geophysical logs	177	437
Total geophysical logs	3,091	4,759
Drillers logs	390	679
Drilling time logs	449	760
Company sample and core studies	157	199
Geologic tops	202	252
General data (completion information)	2,427	3,703
Water well and test hole logs	5,362	3,837
Miscellaneous	179	675
Total new logs received	12,257	14,864

GRU log orders		
In person orders		717
Phone orders		1,952
Mail orders		361
Total orders processed	1,911	3,030

The Survey copy system, implemented in June 1984 under NRIF, continues to provide a vital service to the public. The average number of orders processed per month increased 19 percent over last year. Although visitor days decreased 7 percent from last year, file usage increased 18 percent.

GEOLOGICAL SAMPLES LIBRARY

General

The Geological Survey began collecting samples in the early 1900s when the United States Geological Survey donated a series of drillhole samples to the State Geologist. Today, the Geological Samples Library stores drill cuttings and cores as mandated by Illinois Statute (Chapter 96 1/2 -- Natural Resources Conservation of Oil and Gas). According to U.S. Geological Survey Circular 942, Nonprofit Sample and Core Repositories Open to the Public in the United States, the ISGS Geological Samples Library manages one of the largest collection of geological samples in the United States. The Samples Library staff receives, sorts, processes for storage, retrieves, and conducts all administrative functions required to archive and manage these important collections of samples and cores. This unique samples repository houses an information resource that represents billions of dollars invested in Illinois by petroleum and mining companies for more than 80 years. The collection attracts users from across the country, enhancing the investment potential in Illinois by both in- and out-of-state companies.

Cuttings

During the past year, the permanent file of the Samples Libray acquired 562 sets of well sample cuttings, representing more than 1,071,700 feet of drilling and utilizing 12 linear feet of space. Twenty-eight fewer sets were added to the files; this decline was caused by demands on GSL staff to support other survey projects. The Samples Library files of 65,462 well cuttings represent more than 740,071,744 feet of drilling and utilize 1,400 linear feet in a 3,780 square-foot area in the Samples Library.

An additional 117 oil and water wells await processing. At present, the interval between receipt and permanent processing of samples is 12 months (a 2-month increase). Also, 135 oil well sets requested by the Survey await processing at the Evansville Sample Cut, a commercial firm to which we subscribe (150 sets fewer than last year's balance at the Sample Cut).

Additions to our permanent files consisted of

- 166 oil-test sets received; 164 sets from rotary drill wells washed; 2 sets from cable tool wells processed dry;
- 329 washed sets purchased from Evansville Sample Cut;
- 67 water-well sets processed dry.

The number of samples from oil tests requested by the Survey (365) is considerably lower than last year's 426. We continue to receive about 60 percent of the oil-well sample cuttings requested, and a much lower percentage of water-well cuttings.

Cores

During the reporting year, 104 core sets representing an initial 33,366 feet of drilling were collected, examined, and processed into the permanent files. Included in this year's additions were 5,272 feet of continuous core donated to the Survey from Commonwealth Edison's Stephenson County drill site. This significant core was extensively studied by Midcontinent scientists and was the subject of a report published in the Journal of Geophysical Research (September 1983). Core from two holes representing 1,200 feet of drilling were obtained from the Cominco American, Inc. facility in St. Charles, Missouri. Material Services Corporation donated core from 14 project sites over a wide area of Illinois; Survey staff members are currently evaluating this collection. Also added to our permanent collection were 17 cores representing 7,061 feet of drilling for the Superconducting Super Collider in Illinois preliminary report, and 8 cores condensed from 11,034 feet of drilling from a Department of Energy study of Pennsylvanian rocks in the Illinois Basin. These cores, which were in temporary storage since 1977, present an increase of 31 holes and 28,158 feet of core over last year's additions. The entire collection of 13,054 sets of core on permanent file (representing more than 843,700 feet of core drilling) is stored on steel racks in a area covering approximately 4,300 square feet of the Samples Library.

Other Sample Collections

During the past year, 288 Pleistocene (P-Series) samples were collected, examined, and processed into our permanent files. Our collection in this sample category now totals 23,738 individual samples.

Additional bulk samples that have been chemically analyzed or used as reference materials in research projects were added to the temporary files; 25,500 of these samples are on temporary file in the Samples Library.

John F. Klitzing and Harris R. McKinney, Geological Samples Library, process 5,200 feet of continuous core obtained from a Commonwealth Edison drill site in Stephenson County.

Member of the U.S. Geological Survey team in the mobile spectrographic and sample-preparation laboratory at the Annex facility. The lab is used to analyze insoluble residue samples as part of the USGS/ISGS pilot study.

Supplies

The Geological Survey is required to provide sample bags for the collection of well sample cuttings that are requested by the State. During the past year the Samples Library supplied drillers and operators with 59,150 sample bags for requested well cuttings.

Summary of Service Activities

Requests for services of Samples Library staff increased again during the past year. Telephone requests regarding availability of samples or cores, location information, file numbers, and space to study samples are handled daily by GSL staff.

To ensure that the samples database continues to acquire samples required to provide a representative database for the state, the GSL office has a program to contact drillers by letter to inquire about delivery of requested samples from completed oil tests. Since April 3, 1984 the GSL has been using a Department of Mines and Minerals format for this program. Response to this letter writing campaign has resulted in 60 percent recovery of requested samples. The GSL will continue this program to improve the recovery of requested samples. During calendar year 1985, 158 letters were sent to drillers and operators concerning cuttings for 109 wells requested by the Survey. The 3-year response to this letter campaign is as follows:

	1983	1984	1985
Letters	219	245	158
Response (%)	33%	60%	62%
Wells per letter	.1	.24	.25

Visitors and staff members referred to our files 317 times and retrieved 1,129 sets of samples or cores for examination. A breakdown shows that (1) on 123 occasions 509 sets of samples or cores were examined by staff members at the NRB or Annex facilities; and (2) on 194 occasions, 630 sets of samples or cores were examined by 189 visitors to the Survey facilities (an increase of 11 visitors from last year). Visitors to Annex facilities represent a wide range of geologic interests. Independent consultants and representatives of major oil companies, universities, and governmental agencies are typical visitors to the Samples Library. Of all visitors to the Samples Library, 30 percent were from out-of-state:

60 (31%) independent geologists		58 (31%) representatives of oil companies		71 (38%) representatives of universities or governments	
In-State	Out-State	In-State	Out-State	In-State	Out-State
57 (39%)	3 (19%)	40 (21%)	18 (10%)	34 (18%)	37 (20%)

Samples Library personnel assemble rock and mineral kits for distribution to Illinois schools. The labeled 35-specimen rock, mineral, and fossil set is a collection designed to familiarize teachers and students with rocks and minerals of Illinois. This past year Samples Library staff assembled 138 specimen kits and filled 18 orders to recondition sets already assigned to schools.

The Samples Library office houses the Survey's microfiche collection of well log information and makes sales of copies or assists visitors who wish to examine this collection of 66,161 microfiche (3,160 fiche added). Thirty-six visitors or staff examined or copied 255 fiche during the last reporting period. The ISGS received a microfiche storage cabinet and revised computer printout of the microfiche collection from Petroleum Information as part of their cooperative agreement. Both of these items are in use at the Samples Library Office.

Other Projects

In addition to normal operations, the GSL staff lent support to various ISGS sections projects. Activity levels for the Geological Samples Library staff were at a peak level since occupancy of the facility in 1972. Requests for information, storage space and files for temporary collections, planning for future sample and core additions, and coordinating the shipment of various collections to the Survey placed an increased demand on GSL staff during the past reporting period.

The Samples Library staff coordinated a cooperative project with the USGS and the ISGS in the pilot geochemical study of insoluble residues from Illinois cuttings and cores. Arrangements were made to accommodate a mobile spectrographic lab and a mobile sample-prep lab at the Annex facility. The GSL staff also lent support to the pilot study by identifying and combining insoluble residues for analysis.

The Samples Library office circulates a bimonthly list of selected samples added to our permanent collections. During the last reporting period, this list was changed to include all cuttings and cores added to our permanent files each bimonthly period.

The ISGS has ordered a 35mm camera for photographing core. Upon receipt of the camera, a core photography area will be established in the core examination area of the Annex.

ENVIRONMENTAL GEOLOGY RESEARCH AND SERVICES

Coal and crops—both are important to Illinois. Most coal resources underlie highly productive farmland. About 710,000 acres have been undermined during the past 150 years. The coal and farm industries share the same land and the same interests in preserving the land.

ENVIRONMENTAL GEOLOGY PROGRAM

The Environmental Geology Program addresses concerns of Illinois citizens about their financial security, safety and health in relation to the environment. In the early 1960s, the Survey developed the concept of environmental geology. Now it is a widely accepted field of study.

The aim of this program of research and services is to provide basic geologic data (and interpretations of these data) to assist government, industry, and the public in making decisions and taking actions to protect and enhance the natural environment. ISGS environmental studies focus on groundwater resources, waste management, lakes and rivers, landslides, earthquakes, mine subsidence, and resource-based land-use planning.

ENVIRONMENTAL STUDIES AND ASSESSMENT

The Environmental Studies and Assessment Unit and its parent, the General and Environmental Geology Group, are 2 years old. Three families of grant and contract projects are led by the Unit. All are environmental. All involve several Divisions of ENR. They are Long-Term Ecological Research (LTER) with federal funding from NSF, Lands Unsuitable for Mining Program (LUMP) with federal funding by the Office of Surface Mining via the Illinois Department of Mines and Minerals and Environmental Screening for the Superconducting Super Collider (SSC) with ENR funding from the Build Illinois Program.

Illinois Lands Unsuitable for Mining Program (LUMP)

Lands Unsuitable for Mining Program (McKay, Gross, and DuMontelle). The Office of Surface Mining of the U.S. Department of the Interior continues to fund this program. Its mandates are (1) to respond to petitions from the public and mining companies to have areas reclassified as unsuitable or suitable for surface coal mining operations, and (2) to build a data base to support the petition process and informed decision making. No Lands Unsuitable petitions were received during the year. The major emphasis of the program was on the completion of Geographic Information System (GIS) databases and on quality checking of data.

The program proposed for FY87 will have a new emphasis. It will build a detailed database to assist the Illinois Department of Mines and Minerals with review of mine permit applications submitted by coal mining companies. IDMM will be given direct access to the computers that hold the GIS. Gross and McKay have served as ISGS representatives on the LUMP Steering committee, and McKay and DuMontelle have served on the Prime Policy Committee.

Quality Checking of GIS Data Sets (Krumm and McKay). Data added to the Geographic Information System (GIS) have been carefully checked to ensure the accuracy of the automated data sets. Final checks were made on 56 maps (1:62,500 scale) showing strippable coal reserves, a task requiring detailed inspection of nearly 300 individual maps. Coal map attribute files will be corrected to account for errors identified during the checking process. This completes a 2-year project to automate a total of 81 strippable coal reserve maps. The strippable coal map database represents the largest data set in the GIS. Approximately 50 maps of landform and slope at a 1:40,000 scale were checked and corrected.

Mine Permit Review Pilot Project (McKay, Krumm, and DuMontelle). It has been proposed that the Lands Unsuitable GIS capability be used to assist the Illinois Department of Mines and Minerals (IDMM) with their Mine Permit Review process. The GIS will be used to generate maps on many features (coal deposits, geology, soils) that are part of the GIS database and relevant to issues identified by individual mine permits. Additional data will be automated and added to the system on a site by site basis. A pilot study to demonstrate the utility of this approach has been conducted. Two sites were selected for the pilot project: the Jader No. 4 surface mine in Gallatin County and the Elkhart underground mine in Logan County. Maps have been prepared by five divisions of ENR: the Geological, Water, and Natural History Surveys, the State Museum, and Energy and Environmental Affairs. This pilot project has demonstrated that the ENR LUMP team will be able to automate a large number of the backlog of 200 permits on file at ISMM if the request for additional funding from OSM is granted.

Long-Term Ecological Research (LTER)

LTER Renewal Proposal (Grubb, S. Miller, Cahill, Gross, Holden, and M. Miller). Preparation of the renewal proposal for Phase II of the NSF-funded Large River Site, combined with synthesis of data acquired during Phase I has been a major objective of the ISGS LTER effort during the past year. The project is entering a fifth year of a 5-year grant. The 4-year renewal proposal (for 1987-90) is an integrative effort involving four independent agencies: the State Natural History, Geological, and Water Surveys, and Western Illnois University. Due to the addition of two fluvial geomorphologists (M. Grubb, S. Miller) to the ESA staff, the role of the ISGS in LTER has expanded to include quantitative geomorphic mapping of the physical river system in addition to analysis of the river's function in the landscape and in the ecosystem. These data are vital because they are the fundamental basis for ecological and hydrological modeling of the large river ecosystems.

Automation of Maps for LTER (S. Miller). Base maps for Pool 26 of the Mississippi River have been digitized using the Geographic Information System (GIS). The maps include water/land boundaries of the Mississippi and Illinois Rivers, backwater areas, island, bluffs, floodplains, and tributaries. GIS efforts are now focused on updating existing data sets and incorporating biological data for Pool 19 in order to enhance ecosystem modeling efforts.

Sediment in Mississippi River Pools 20 through 25 (Holden, Grubb, S. Miller, Gross, Alam, Cahill, and M. Miller). During the summer of 1985, main channel bottom sediment samples were collected between Pool 19 and Pool 26 of the Mississippi River. Textural analysis of the samples reveals no downstream-fining trend of the sediments. Previous bottom sediment studies (Casavant, 1983; Goodwin and Masters, 1983) indicate a textural downstream fining in Pool 19 and no textural trends in Pool 26 above the Mississippi Illinois Rivers confluence. This reconnaissance study will be presented in May at the 18th annual meeting of the Mississippi River Research Consortium in La Crosse, Wisconsin.

Having completed studies on the sediment in Pools 19 and 26 of the Mississippi River, the LTER team is turning attention toward the floodplain and an analysis of the geomorphic stability of the system. During the spring and summer of 1986, the ISGS plans (1) to initiate detailed geomorphic mapping of Pool 19 and (2) to conduct field work on a complex of islands in Pool 19 of the Mississippi River near Burlington, Iowa.

History of Sedimentation in Pool 19 of the Mississippi River (Gross, Cahill, Casavant, and Adams; Bhowmik, State Water Survey). In a joint effort of the ISGS and the ISWS, three methods were used to determine the recent sedimentation rates in Pool 19, a pool formed by the highest dam on the river system. Suspended sediment was measured as it flowed into Pool 19 through the upstream Lock and Dam 18, at all major tributaries to Pool 19, and at the output through the downstream Lock and Dam 19. Bathymetric cross sections were compiled from surveys in 1891, 1928, 1936, 1946, and 1983. Cs-137 and Pb-210 were used to date sediment cores. With the closure of Lock and Dam 19 in 1913, pool volume decreased at a rate of 1.5 percent per year. Net deposition of sediment is still occurring and pool volume is presently decreasing at a rate of 0.6 percent per year.

Conceptual Models of Erosion and Sedimentation in Illinois (Gross; Bhowmik, State Water Survey; Risser, Natural History Survey). A summary manuscript was published in June in the Proceedings of the World Congress on Water Resources in Belgium. The original, massive work, was published in 1984 in two volumes as Illinois Scientific Surveys Joint Report 1.

GEOLOGY FOR PLANNING

Geology for land-use planning was the original objective of environmental geology when this term was coined at the ISGS in the 1960s. Resource-based land-use planning involves mapping the vertical as well as areal distribution of geologic materials and presenting this information in a form nongeologists can understand and use. Planners are given information on favorable areas for burying wastes, locating water resources, building roads, houses, or large industrial facilities, and exploring for mineral resources.

Siting the Superconducting Super Collider in Illinois

The State of Illinois is vigorously pursuing the Superconducting Super Collider (SSC) project. The world's largest particle accelerator operates at Fermi National Accelerator Laboratory in northern Illinois. It is a machine 4 miles in circumference. A larger machine is under construction in Europe, a still larger machine is in the early phase of construction in the USSR, and the U.S. Department of Energy is engaged in the design of yet a still larger machine, the SSC, which will be 52 miles in circumference. DOE will decide whether to build the SSC later in 1986. Choice of a site should be made in FY87, and construction begin in FY88. The purpose of the machine is to study the basic nature of matter. The SSC will serve as a world center of science and will provide the equipment and the setting necessary for major advances in high energy physics.

Illinois will be in competition with other states for the SSC. To ensure a sound site and a competitive proposal, DENR has been assigned the role as lead agency for the State; and the Illinois State Geological Survey is assisting in the coordination of the effort and in providing technical information useful in the siting and engineering design of the SSC.

State of Illinois Proposal to U.S. Department of Energy (Kempton, Gross, and entire ENR team). The first draft of the Illinois proposal to the U.S. Department of Energy will be completed in June. The Scientific Surveys, the State Museum, the ENR legal counsel, and many other Departments of state government are preparing materials. Illinois Institute of Technology Research Institute (IITRI) is compiling the proposal.

SSC Project Administration (Gross, Kempton, Hines, Leighton and many others). ENR has organized two task forces to provide data and advice for this very large project. John P. Kempton heads a Geological Task Force working within the Geological Survey. David L. Gross heads an Environmental Screening Task Force that includes staff from all three Surveys and the State Museum. Dr. Gross serves as the SSC liaison within ENR and for some of the interdepartmental work.

Environmental Atlas (Hines and all divisions of ENR). An environmental atlas, consisting of 40 maps and accompanying text is in review and targeted for July 1986 publication. The Atlas depicts environmentally relevant data, including geological, biological, cultural, and historical characteristics that have been identified and described by the three Surveys and the State Museum. This document will be included in the Illinois proposal to DOE and is intended to demonstrate to the SSC Central Design Group, legislators, and other interested parties the amount and quality of information that the State has available for assessing the impacts of siting the SSC in Illinois--especially siting that avoids fatal flaws.

Geotechnical logging of bedrock cores drilled during the exploration of a site for the proposed Superconducting Super Collider. Robert C. Vaiden, Robert J. Krumm, and Robert A. Bauer are members of the Geological Task Force.

Superconducting Super Collider siting project: borehole logging at a controlled test hole. Philip C. Reed is a member of the Geophysical Unit.

Geological Studies (Geological Task Force). The results of the geologic mapping and the data obtained from the test drilling have confirmed that the region west of Fermilab is suitable for siting the SSC. Evaluation of the geologic/geotechnical and hydrogeologic data suggests stable, uniform, and predictable geology with little or no adverse impact either of groundwater on tunneling or of a tunnel on local groundwater resources. Fracture patterns are systematically oriented in a generally northeast-southwest and northwest-southeast orientation suggesting that a roughly north-south orientation for the experimental area is the best.

The second phase of the first test-drilling program was completed in mid-July, ending with 7 test holes for the period and 16 total for the program. An additional test hole was drilled as a tie-in hole for a test seismic profile line. A report on the first 9 test holes (fall 1984, phase 1) is in the formal review process prior to publication, and a report on the remaining test holes is nearing completion. An interim report summarizing all geological-geochemical studies for the entire SSC study area is also nearing completion.

Geotechnical Support for SSC Project (Bauer, Hasek, and Su; Schmidt, State Water Survey). Rock mechanics testing has been performed on boreholes F-4 through F-16 (excluding F-8 and F-13). Approximate numbers of tests performed include 121 unconfined compressive, 363 indirect tensile, 363 axial and 363 diametral-point load tests, 363 moisture, 121 specific gravity, 2,420 shore hardness, 150 triaxial strength, 39 taber abrasion, and 60 schmidt hammer tests. This information along with the compilation of the drilling data, rock discontinuity descriptions, and estimates of water inflow into the tunnel has allowed us to determine (1) the rates a tunneling machine can advance through the Galena formation, and (2) the types of supports required for the tunnel and experimental chambers' roof and walls for static and seismic conditions. The analysis shows that the tunneling operation would be faster than the rates experienced by the successful Tunnel and Reservoir Plan (TARP) project in Chicago and that the tunnel would be self supporting, requiring rock bolts occasionally where conditions warrant. Samples of the Galena have been sent to two tunnel boring machine manufacturers. Their analysis of the samples will result in an estimate of the rates of advance of a tunneling machine in the Galena.

Natural Radioactivity Assessment in the SSC Siting Area (R. Gilkeson and Laymon). Information on natural background radiation in the SSC siting area is being gathered and integrated into an assessment of the total radiological quality of the natural environment. Sources being assessed are (1) gamma radiation at the land surface, (2) radon-222 in indoor environments and in underground shafts and tunnels, and (3) dissolved radon-222, radium-226, radium-228, uranium-234, and uranium-238 in groundwater.

The available information has been gathered into a preliminary report that identifies aspects of the natural radioactivity environment needing further characterization.

Feasibility of Using Sand and Gravel Pits and Quarries for Disposal of Refuse from Tunneling Associated with the SSC Project (Berg and Hannah). This project involved the mapping of abandoned and active sand and gravel pits and quarries in the vicinity of the proposed SSC ring for purposes of disposing of refuse associated with coring operations. A total of 8 sites was located within about 10 miles of the proposed ring.

Evaluation through Laboratory Studies: Impact of the Superconducting Super Collider Tunnel Spoil on Surface and Groundwater Supplies (Krapac, Roy, Griffin, and Beissel). As part of the feasibility report for siting the SSC tunnel in Illinois, an environmental assessment of the tunnel spoil material is being made. It is currently proposed that materials excavated during tunnel construction will be disposed of at surface facilities. The nature of leachates from the spoil material and the impact of leachates on water supplies has therefore been investigated.

Extract data indicate that of the 27 constituents determined in the laboratory extracts, only 8 constituents (B, Ba, Cl, K, Mg. Na, Si, and SO_4) had concentrations greater than analytical detection limits. Average extract concentrations, when compared to discharge effluent standards, were below standard (acceptable) concentrations. These laboratory extracts indicate that the tunnel spoil would generate relatively innocuous in-situ leachates, having a relatively small impact on the quality of water resources.

Seismic Test Traverse and Supporting Studies (Heigold and Geological Task Force). Evaluation of the geologic setting shown by the geologic maps and test drilling strongly indicates the suitability of the region for the SSC tunnel within bedrock. To tie in the results of the SSC studies with the successful Tunnel and Reservoir Plan (TARP) for Chicago, seismic reflection and refraction tests were run along a 25-mile traverse along the southwest side of the SSC study area.

Supporting studies for the line includes drilling and coring a test hole at the south end of the traverse and obtaining continuous velocity and density logs to provide data for constructing synthetic seismograms. The test hole (17) was completed in August 1985, and data for the synthetic seismogram was provided to the service company prior to the October traverse.

Results of the seismic traverse are being analyzed. Reprocessing of the seismic data is being undertaken to improve record quality; and other approaches to obtain the desired seismic information are being investigated.

Satellite Image Maps (Stohr). Two Satellite Image Maps of Illinois have been printed. Both are of extraordinary quality and represent a significant advance in the state of the art. The maps were developed as part of the Illinois efforts on the SSC project. One is at a scale of 1:500,000 and illustrates the entire state. The other is at a scale of

1:200,000 and illustrates the northeastern portion of the state including both Chicago and the area proposed for the SSC. The second map consists of a satellite image map on one side and a land-use map on the reverse.

Mitsubishi/Chrysler Plant Location

Geotechnical Information for Proposed Sites for the Illinois Mitsubishi/Chrysler Automobile Assembly Plant (DuMontelle). Geotechnical information about the construction conditions and the availability of water for a Mitsubishi/Chrysler automobile assembly plant was provided to the Department of Commerce and Community Affairs for proposed sites north of Morton and west of Bloomington/Normal in Illinois. Both sites were found to be well suited for construction. For the Normal site, ample water supples from sand and gravel aquifers were located nearby.

Other Projects

Engineering Geology of Chicago (Dixon; and Maynard, Chicago Department of Public Works). This paper for the Bulletin of the Association of Engineering Geologists will be part of the series, Geology of the Cities of the World. The discussion includes the geologic factors that have affected the growth and development of Chicago and the geotechnical methods used to found structures and mitigate various environmental constraints.

Sources of Information on Engineering Geology and Related Topics for Northeastern Illinois (Dixon and DuMontelle). This resource document, published as EGN 110, indicates the basic data and services available for northeastern Illinois. It was produced jointly by the Geotechnical Division of the Illinois Section of the American Society of Civil Engineers, and the North-Central Section of the Engineering Geologists, in cooperation with the Illinois State Geological Survey.

Geology for Planning Coal Mining in Perry County (Berggren, Danner, and McKay). Geologic information for Perry County is being provided in a form useful for coal mine planning, construction, and operation; for mining regulation; and for both private interests and public policy. This project is intended to help coal mine operators, public officials and interested citizens plan for long-term coal development in Perry County. In 1984 Perry County's six mines produced 15.0 million tons of coal--23 percent of the state's total production. Previous studies have reported 2,096 million tons of coal reserves.

This study, envisioned as the first in a series of similar county reports, will utilize the ENR Geographic Information System (GIS) for project maps. Field work and the results of limited test drilling, conducted in September and October, are being incorporated into the maps. Efforts have been concentrated on Quaternary materials to provide stratigraphic control for the overburden studies. Design of the GIS work and of the final report is underway.

WASTE MANAGEMENT

The Survey's program in waste management began in the early 1960s and has expanded greatly over the years as Illinois has become a major producer of hazardous and nonhazardous wastes. The Survey program of waste management is interdisciplinary, incorporating several geologic and chemical specialities.

To help in the urgent task of developing methods of managing wastes safely and economically, the ISGS and the other two Surveys, the State Museum, and DENR's Springfield office this past year formed the Hazardous Waste Research and Information Center (HWRIC).

Landfills/Septic Systems/Groundwater Contamination

Statewide Landfill Inventory (Dixon, Hensel, and Mehnert). This project consists of six tasks:

- The inventory of known and newly permitted disposal sites in Ilinois continues to be compiled from all potential sources and will describe each sites's location, type, hydrogeologic setting, waste(s), and background.

- The locations of past generators of hazardous wastes will be used as centers from which to search for unrecorded waste disposal sites.

- A list of sites needing hydrogeologic studies will be compiled and prioritized on the basis of the type and amount of wastes disposed and on the relative susceptibility of the geologic setting at each site to pollution.

- In order of need, the sites listed by Task 3 will be studied on a preliminary basis from information in the files of ISGS.

- Information from the Statewide Landfill Inventory will be incorporated into the HWRIC database.

- A report and map will be prepared to show the status of the inventory at the close of the reporting period for fiscal year 1986.

The project is funded by the Department of Energy and Natural Resources through the Hazardous Waste Research and Information Center.

Inventory of Abandoned and Active Quarry Sites in Northeastern Illinois (Mikulic). Information on the geology, size, location, and history of all quarry sites in northeastern Illinois is being assembled to serve as a database for future planning and development and to determine if abandoned quarry sites already developed pose environmental problems. Stone quarried from local Silurian rocks has been an important building material in the Chicago area for almost 150 years. Many early quarry sites have long been abandoned and covered leaving no exact

record as to their location, size, and the type of material with which they were filled. This lack of information may result in future environmental or engineering problems following development of these sites in the rapidly growing Chicago metropolitan area.

Earthen Liners: A Field Study of Transit Time (Cartwright, Griffin, Herzog, Albrecht, Krapac, Moffett, Risatti, Stohr, and Su) Performance of a field-scale compacted earthen liner will be evaluated in a 3-year U.S. EPA-funded project that began in late 1985. Objectives are (1) to determine transit times for water flow and nonreactive solute transport through a partially saturated field-scale liner, and (2) to test the accuracy and practicality of available methods for predicting these transit times. A study site has been selected in Champaign County, Illinois, and plans are being developed for the construction of a small field liner prototype in 1986 and the construction of the field-scale liner itself (about 25 x 33 x 1 meters) in 1987.

A poster presentation of the project was well received at the annual research contractors' meeting held at the U.S. EPA Laboratory in Cincinnati. The exhibit was kept for display.

Hydrogeology of Sewage Sludge Land Application Areas in Rockton Township, Winnebago County, Illinois (Berg, Morse, and T. Johnson). This project is evaluating potential contamination of groundwater from the application of sewage sludge on agricultural lands in Rockton Township. Since late 1983, 15 wells have been monitored and results show that the groundwater contains more nitrates in areas where sludge has been applied than where it has not been applied. Analyses also show that groundwater pH, hardness, ammonia-nitrogen, chlorides, specific conductivity, and detergents may also be affected to some degree by sludge applications. There does not seem to be any groundwater degradation due to heavy metals and organic chemicals. The wells were sampled seven times between 1983 and 1985.

Study of Geology and Groundwater at a Sewage-Sludge Land Application Site in Winnebago County (McKenna, E. C. Smith, Berg and Morse). This project, recently funded by the Sanitary District of Rockford, will characterize the hydrogeologic setting and establish a groundwater monitoring network for a test plot to determine the feasibility of spreading dehydrated vacuum filter cake from municipal sewage-sludge on agricultural land. Groundwater quality data from this investigation will be compared to our sludge study near Rockton.

Coal Wastes

Determination of Mineral Content of Discharge Material to the Sedimentation Pond at Turris Coal Company (Hughes). This study is designed to monitor the composition of coal tailings in this pond and to see if a reasonably consistent composition will allow Turris to use ponds without a separate clay liner. A contract in the amount of $6,390 has been awarded by Turris for this study in 1985-86.

Hazardous Toxic Wastes

Evaluation of Current Underground Injection of Industrial Waste in Illinois (Brower, Krapac, and Hensel; Visocky, Payton, and Nealon, Water Survey; and Guthrie, University of Illinois). Legislative bills culminating in the Environmental Protection Act, January 1, 1985, mandated an assessment of underground injection of hazardous industrial wastes in Class I disposal wells in Illinois--an assessment that we have prepared for the General Assembly and Office of the Governor.

Injection in 1984 totaled 310 million gallons and was targeted in disposal zones lying 1,540 to 5,524 feet below the surface. Review of the regulations and the regulatory practices for this class of disposal wells in the underground injection control (UIC) program has shown them to be essentially effective in protecting underground sources of drinking water (USDW), human health, and the environment. Disposal zones and their associated confining intervals in selected geologic units across the central two-thirds of Illinois have the capacity to accept injected wastes at low-to-moderate injection pressures and to provide long-term confinement of these wastes. Analysis of well siting, construction, operation, monitoring, and testing has shown these to be adequate for Illinois' seven disposal facility sites. Waste stream characterization has shown no significant incompatibilities between injected wastes and components of disposal zones. Comparison of economic and environmental impacts for deep well injection and a number of alternative disposal technologies has shown deep well injection to be less expensive and to have, in many cases, a lower potential environmental impact than other systems.

Evaluation of Groundwater Monitoring Programs at Hazardous Waste Disposal Facilities in Illinois (Herzog, Hensel, Mehnert, J. Miller, and T. Johnson). This study of groundwater quality in Illinois was mandated under the Currie Bill (HB 3193). It focusses on groundwater quality in the immediate vicinity of hazardous waste disposal facilities with an emphasis on the adequacy of groundwater monitoring programs at these facilities. Ten facilities around the state are located in Bureau, Cook, Crawford, Lawrence, Macoupin, Madison, Peoria, Will, and Winnebago Counties.

This study showed that there has been a dramatic improvement of the quality and quantity of groundwater monitoring at hazardous waste facilities in Illinois over the past 10 years. Although many monitoring plans could be improved, all of the programs studied were capable of detecting groundwater contamination to some degree. Contaminant migration has been detected at some facilities, resulting in further monitoring to determine the extent of this migration. At other facilities, reliable monitoring systems have been installed recently to provide an accurate picture of groundwater quality.

Five major conclusions came from this study: (1) thorough hydrogeologic studies are necessary before adequate monitoring programs can be established, (2) design of groundwater programs should consider

individual site characteristics, (3) additional monitoring techniques (such as geophysical techniques) should be utilized more often, (4) adequate record keeping is essential for determining changes in water quality, and (5) additional attention should be paid to on-site waste disposal and generators of hazardous waste. Comments on the draft report have been received and final revisions are underway.

Ground Magnetic Surveys on Hazardous Waste Sites (R. Gilkeson, Laymon, and Heigold). Magnetic surveys are commonly used to search for buried hazardous wastes. The interpretation of magnetic data gathered on these surveys is generally empirical. Studies at ISGS have established the important role of mathematical models to assist in the design of magnetic surveys and constrain the interpretation of field data. Illinois State Geological Survey scientists have also used field measurements and theoretical models to characterize the magnetic anomalies generated by a single steel drum buried at various depths.

An Assessment of Class V Injection Wells in Illinois (Hensel and E. C. Smith). This project is currently at the startup stage. The Illinois State Geological Survey, in cooperation with the Illinois State Water Survey, and with funding from the Illinois Environmental Protection Agency (IEPA) will study the degree of risk to groundwater resources from Class V injection wells and enumerate the criteria which should be considered by IEPA for regulation of these wells. Class V injection wells are defined as wells that inject nonhazardous fluids into or above geologic units that yield drinking water. Class V wells include those used for disposal of domestic and industrial nonhazardous waste, storm water runoff, heat pump return, and agricultural drainage. In Illinois, nearly 1750 Class V injection wells have been reported.

Investigation of Failure Mechanisms and Migration of Industrial Chemicals at Wilsonville, Illinois: Hazardous Waste-Clay Interactions (Hughes, Austin, Warren, Griffin et al.). Research on the effects of organic solvents on earth materials was completed this past year at the Wilsonville hazardous waste site. X-ray diffraction (XRD) of a swelling clay (smectite) with hazardous waste mixtures showed a tendency of individual chemicals to collapse clay minerals. This collapse can promote leakage of hazardous wastes. Further estimates of the effects of wastes on clays were developed from viscosity measurements of clay-water-waste slurries.

Such studies are contributing to our understanding the behavior of clay minerals in landfill liners and in trench covers where they are the main constituents used to seal the impoundment. Expansion or contraction of the clays can disrupt continuity of the liner or cover. The observations suggest that screening the compositions of different clays for use as clay liners is required.

Currently we are now studying the tendency of clays to absorb immiscible organic wastes, the tendency of absorbed wastes to desorb water, and methods to treat added or naturally occurring clays that give high absorption selectivities for hazardous wastes.

Investigation of Industrial Chemical Pollution of Groundwater at Wilsonville, Illinois (Geochemistry, Groundwater, and Engineering Sections). Work on the U.S. EPA sponsored portion of the project at the hazardous waste facility at Wilsonville, Macoupin County, is complete and a final report is in preparation. Our research has determined the reason for organic contaminants migrating 100 to 1,000 times faster than predicted. The flow of contaminants occurred mainly through joints. The joints formed by dessication cracking in a polygonal pattern as a result of drying within the weathered zone of the upper part of the Vandalia till.

More than 40 wells were installed on the site with the cooperation of the owner and the Illinos Environmental Protection Agency to monitor the activity. This site provides a useful field laboratory for continued investigations of migration mechanisms of pesticides and testing of a wide range of constituents; hence plans have been developed to extend the work, testing for priority pollutants and interactions that occur under field conditions.

Assessment of Ecotoxicological Hazard of Waukegan Harbor Sediments (Risatti and Sheridan; Ross and Henebry, Natural History Survey). This study will make geochemical and biological assessments of the potential risks associated with contaminants that may have accumulated in the sediments of Waukegan Harbor. Sediments will be sampled on a grid of 20 stations and concentrations of metals and PCBs will be determined. These data will be computer processed and mapped for all contaminants detected; and dispersal patterns will be identified by spatial autocorrelation techniques. Toxicity tests using bacteria, algae, and nematode species will be performed on extracts of the sediment samples. In addition, a community-level bioassay (protozoan colonization) will be carried out in situ. These tests will determine which areas of the harbor might present especially high environmental risks. Benthic insect larvae and small fish collected from the site will be assayed to estimate bioaccumulation factors for selected pollutants. Field and laboratory measurements of microbial anaerobic degradation of PCBs will be made to estimate the residence time of these compounds in undisturbed sediments.

Preliminary Assessment of Pesticide Contamination in Soils and Groundwater (McKenna, J. Chou, and Griffin; LeSeur, State Water Survey). This study by the State Geological and State Water Surveys, is funded by the Illinois Department of Energy and Natural Resources. It is the first detailed field investigation in Illinois of non-point source contamination of groundwater by agricultural pesticides. Reports of pesticide contamination in wells in the central sand region of Wisconsin and in the Devonian carbonate aquifers and the Big Spring Basin of Iowa cause concern that similar pesticides may be present in rural well water in Illinois.

The purpose of this study is to determine whether widely used pesticides are leaching into groundwater in a region highly susceptible to such contamination. In this study, a 25-square-mile region located

Robert A. Griffin, Head of Geochemistry and Acting Head of Groundwater, steaming a well casing at a hazardous waste site.

Sherry Otto, IEPA, collects soil samples from a hazardous waste site for chemical analysis.

Field engineer purges well at Wilsonville before collecting water sample. The site operator and the ISGS cooperated to sample both company and Survey wells at the same time to get a clearer picture of chemical migration at the landfill.

in Mason County along the Illinois River in the central part of the state was selected. In December 1985, 14 shallow monitoring wells were installed and groundwater samples were analyzed for pH, conductivity, temperature, nitrate (NO_3-N), and pesticides. At two sites, well "nests" consisting of two vertically spaced wells were installed to determine vertical hydraulic gradients and vertical differences in water quality. The monitoring wells and 24 shallow domestic wells will be sampled just before and just after application of pesticides to farmland in the spring of 1986. Soil samples collected during installation of the monitoring wells are being analyzed for grain size, total organic matter content, and sorption capacity. Additional soil and groundwater samples will be collected after pesticide application in spring, 1986 to evaluate the downward migration of pesticides.

Geochemical Interactions of Hazardous Wastes with Geological Formations in Deep-Well Systems (Roy, Griffin, Krapac, and Dickerson). A cooperative agreement between the Hazardous Waste Research and Information Center, the U.S. EPA, and the State Geological Survey, this new research with provide basic geochemical data to permit a better understanding of the physicochemical interactions of liquid hazardous wastes with subsurface rock formations and associated saline brines.

This project should help define the requirement for review in the permitting process, and the long-term fate of injected fluids. It should also help identify the mechanisms by which hazardous wastes are rendered nonhazardous by naturally occurring chemical reactions in geologic strata.

Batch-Type Adsorption Procedures for Estimating Soil Attenuation of Chemicals (Roy, Krapac, J. Chou, and Griffin). The American Society for Testing and Materials (ASTM) and the U.S. EPA (source of funding) cooperated with Survey investigators in this project. The objectives were (1) to develop standardized-batch-adsorption procedures for the measurement of contaminant adsorption data applicable to the location, design, and permitting process of hazardous waste sites; and (2) to prepare a Technical Resource Document (TRD) detailing the routine uses of the procedures and their scientific basis and rationale, as well as providing guidelines for the interpretation and application of adsorption data.

Results included an ASTM emergency standard method for measuring contaminant retention by soils and sediments. More comprehensive procedures are given in a draft final report (the TRD), which is currently in review. The TRD will be introduced into Public Comment via the Federal Register later this year. The data generated by these procedures can be used in computer-assisted modeling efforts to assess the migration of contaminants from hazardous wastes sites.

In Situ and Laboratory Study of the Microbial Degradation of Organic Pollutants in Sediments, Landfill Sites and Ground Water Systems (Risatti, Chou, Griffin, Sheridan, K. Miller, and Feldman). Laboratory studies have been initiated to assess and quantity the factors limiting

the extent and rate of biodegradation of organic chemicals by microorganisms. The knowledge gained from laboratory studies will be applied to develop methods for microbial degradation and removal of organics in subsurface environments. Anaerobic and aerobic microorganisms indigenous to natural systems may offer an efficient means of ameliorating the effects of organic pollutants in sediments, landfill sites, and groundwater systems. Although there is an extensive body of general knowledge concerning microorganisms in these systems, little is known regarding the impact of these microbial communities on synthetic organic compounds and the resulting biochemistry of carbon flow.

In this study several strategies are being employed (1) to define the effects of various concentrations of organic pollutants of microbial activity, (2) to identify environmentally noxious organic compounds that are amenable to anaerobic and aerobic microbial degradation, (3) to identify products resulting from microbial degradation of pollutant organics and elucidate degradation pathways that may also be occurring in sediments, landfills and aquifers, (4) to determine rates and microbial degradation of pollutant organics, and (5) to identify and isolate organisms capable of degrading specific organic pollutants in order to develop microbes that can more efficiently utilize environmental pollutants. An understanding of microbial adaptation to high concentrations of organic chemicals in subsurface environments will enable prediction of biotransformations and the derivation of reaction-rate coefficients for modeling the fate of chemical pollutants.

This work has been integrated with ongoing research into

- microbial PCB degradation in the anaerobic sediments of Waukegan Harbor;
- anaerobic degradation of phenolic compounds in groundwaters and waste-treatment facilities (undertaken with the University of Illinois Civil Engineering Department);
- performance of field-scale clay liners (funded through the U.S EPA, Cincinnati, OH);
- pesticide contamination of groundwater in Madison County, Illinois.

Low-Level Radioactive Wastes

Geologic and Hydrologic Criteria for Siting of a Low-Level Radioactive Waste Disposal Site in Illinois (Berg, J. Miller, and T. Johnson). The Illinois Department of Nuclear Safety is funding a cooperative ISGS-ISWS study to develop a comprehensive list of criteria to be used in siting a low-level radioactive waste disposal facility. Criteria important in near-surface disposal (such as presence of aquifers or areas of natural resource concentration) have been mapped on a statewide scale and may be used to differentiate potentially unsuitable from suitable areas for near-surface disposal. To date, two phases

of the project are complete: (1) regional aquifer screening maps and (2) regional and site-specific geologic and hydrologic criteria and recommendations for siting. The entire project is to be completed by June 30, 1986, and will include methodological approaches used in site descriptions and site comparison criteria. All information will be published by the Survey.

The GIS is being used to produce maps of factors that influence the suitability of land areas for disposal of low-level wastes. Maps of geologic, hydrologic, cultural, demographic, and natural resource factors have been produced by reformatting and combining map data put into the GIS.

Hydrogeologic Experience at a Low-Level/Shallow Land Burial Site: A Look Toward the Future (K. Cartwright, J. Miller, and R. Berg). The 8th Annual Symposium on Geotechnical and Geohydrological Aspects of Waste Management included a paper discussing inadequacies in regional siting and site characterization of the Sheffield low-level radioactive waste disposal facility and the problems that could have been avoided through more modern siting methodologies. Site characteristics should be based upon recognition of a predictable sequence of geologic materials and absence of continuous layers of permeable materials. Computer mapping on a regional scale can augment site selection activities.

Study of Trench Covers to Minimize Infiltration at Waste-Disposal Sites (Cartwright, T. Johnson, Larson, Moffett, and Albrecht). This study of trench cover designs, funded by the U.S. Nuclear Regulatory Commission through the University of Illinois, was initiated in October 1980 because of concerns related to the leakage of low-level radioactive wastes at the Sheffield disposal site.

Several designs of layered-soil covers were tested through laboratory, computer and field simulations. The layered covers varied in their ability to impede infiltration, but all limited infiltration more than did a conventional cover. The draft final report for this contract has been submitted; however, monitoring of the field site is continuing. A supplementary monitoring report will be submitted at the conclusion of the project.

Service Activities Related to the Hydrogeology of Waste Disposal

Reports are prepared upon request for the Illinois Environmental Protection Agency and local health agencies to aid in processing applications for operation of disposal facilities. These reports require a compilation of all available surface and subsurface geologic information and a field survey of the sites by one of the Geological Survey's professional staff. During the reporting period, 39 reports and related letters were written about existing or proposed waste disposal facilities. The counties involved in these reports and letters were Boone, McHenry, Kane, Cook, Will, Bureau, Peoria, Madison, St. Clair, Champaign, Vermilion, Cumberland, Clark, Lawrence, Marion, Jefferson, Saline, Alexander, and Pulaski. In addition, some questions were

handled directly through telephone calls or through discussions with visitors, consultants, and the EPA.

Survey staff provide consultation to the IEPA on hydrogeological aspects of underground injection of industrial wastes in Class I wells. This class of disposal wells is administered under regulations of the Underground Injection Control (UIC) program. All wells are being operated under rule, while permits are under review following receipt of the UIC program by the State. The Geological and Water Surveys are conducting technical reviews of these permits. In addition, field visits to the well sites have been made to observe tests and well operations. About 75 questions concerning this method of waste disposal were handled over the telephone or through discussions with visitors. Interest in deep well disposal of all types of liquid wastes is expected to increase following recent changes regarding administrating the various types of waste disposal.

GEOLOGICAL STUDIES OF ILLINOIS LAKES AND RIVERS

Lake Michigan Research and Service

Over the past 15 years, the Geological Survey has acquired an impressive information base for support of research and services in southern Lake Michigan. It contains data on more than 800 bottom grab samples, 300 bottom cores, 2,000 miles of geophysical profiles from 12 major lake cruises, 20,000 slides, 1,600 high altitude photos, and more than 30,000 chemical analyses. Dozens of ISGS publications and contract reports deal with environmental chemistry of sediments, stratigraphy of lake sediments, shore stabilities, fishery breeding sites, glacial till distribution, history of the lake, and history of lake levels. These data make possible service to numerous federal, state, and county and municipal agencies as well as to the public; however, service requests from community organizations, as well as riparian owners, have recently exceeded the capacity of our small research team to respond.

During the year the main preoccupation was with rising and persistently high lake levels and the development of a program to provide technical assistance to the Illinois shore. Considerable effort and energy was devoted to planning and assisting DENR in preparation for the "Governor's Conference on Lake Michigan--Illinois' Great Lake." The Scoping Study for Lake Michigan, which provided a basis for the Governor's conference, has been much used by research and service agencies.

Scoping Study for Lake Michigan Issues (Holm, Gatz, and Collinson). Funded by the Board of Natural Resources at $33,600 for one year beginning August 16, 1984, this study was designed to review present and past research in Lake Michigan. The purposes were to evaluate research needs and establish priorities for state supported research in Lake Michigan.

Erosion due to wave action along a lake shore.

Glencoe, July 1985: emergency shore protection in response to abnormally high lake levels. Contractor is reveting the Lake Michigan shore by adding large stone blocks called rip rap to stabilize the toe of the bluff and prevent erosion by wave action. This is one of more than 30 similar projects completed on the Illinois shore in 1985.

This project was completed on August 31, 1985. More than 200 individuals at state, federal, and local agencies and universities were contacted regarding their current reseach projects and their views on research and service needs for Illinois' involvement on the lake. From these interviews and additional sources, information on 270 current (1983 and beyond) research projects were compiled and entered into a computerized database. In addition to the project listing, a computerized bibliography containing over 4,000 articles covering research in all fields, has been compiled. A summary report was written that identified the gaps in research, the areas of heaviest concentration of efforts and major sponsors of research, and that recommended a program of research priorities for the State Scientific Surveys.

Information from this project has been provided to the Great Lakes Commission, the International Joint Commission, Argonne National Laboratory, the Lake Michigan Interleague of Women Voters, The Center for Great Lakes, consultants for U.S. EPA, and other researchers.

Lake Michigan Research Information Database (Holm). A grant of $9,567 was obtained from the Joyce Foundation, Chicago, IL, to continue work for six months (November 1, 1985 to May 31, 1986) on the project listing and bibliography on Lake Michigan. These are currently being updated and edited. The bibliography has grown to 5,000 entries. Numerous requests for information on Lake Michigan from researchers and agencies have been answered.

Illinois Shoreline Erosion Interim I--Lake Michigan (Collinson and L. Smith). In July, 1985, the U.S. Corps of Engineers requested an update of the shoreline position. In August, 18 one-page maps of the shore were delivered. They were published in December 1985 as Illinois Shoreline Erosion, Interim I--Shoreline Positions, Pls. 1-18 in Illinois Shoreline Erosion: U.S. Corps of Engineers, Lake Michigan, Summary Information Report.

Lake Michigan Sediment Studies (Cahill). Since 1969 the Illinois State Geological Survey has been conducting investigations of the bottom sediments in Lake Michigan.

To determine recent sediment movement, we measured the levels of the element, ^{137}Cs, of 175 grab samples of the upper 3 cm of sediment. This element, derived mainly from nuclear explosions, is a direct measure of man's activities and can be used to help trace recent events chronologically. ^{137}Cs level correlated well with concentrations of organic carbon, lead, and other anthropogenic trace metals in the sediment. Atmospherically derived ^{137}Cs and trace metals are being redistributed by sedimentary processes in Lake Michigan after being incorporated in suspended sediment. A paper was presented at the Fourth International Symposium on Paleolimnology on the distribution of ^{137}Cs in the recent sediments in Lake Michigan. The paper will be published in Hydrobiologia in a special symposium volume.

Hydrography and Sedimentology of the Zion-Beach Park-Winthrop Harbor Marina Site (North Point Harbor) (Collinson, L. Smith, Sargent, and Norby). In April 1985, new hydrographic profiles were run, and in June, a new detailed hydrographic map was completed. By July, shore recession maps were drafted, preparing the way for littoral estimates and design heights to be completed and set to the contractors in January 1986. In addition, maps defining depth to till, sand thickness, and depth to bedrock maps have been completed.

Aerial and Land Reconnaissance of the Lake Michigan Shore (Norby, Collinson, Sargent, and Grubb). Two aerial photographic flights and several land photographic trips were made during the year. More than 200 slides were distributed and used for the Governor's Conference, in a number of publications and by other organizations.

Response to Lake Michigan Shore Erosion (Collinson and L. Smith). This 5-month, $27,000 project began February 1. Funded by the ENR Environmental Research Fund, it involves the inventory of the Lake Michigan shore, the preparation of a recommended shore protection plan, and the revision of design standards for Illinois shore protection structures. Work is underway on a computer file and a shore atlas.

The Role of Silurian Bedrock Reefs in the Lake Michigan Lake Trout Fishery (Collinson and Holm). Federal assistance has provided $17,896 for a one-year FY87 study overseen by the Illinois Department of Conservation. The project will consist of sedimentologic and geomorphic studies conducted in cooperation with William Horne's project on the viability of trout eggs on Julian's Reef.

Lake Chronology in the Lake Michigan Basin: 15,000 RCYBP to Present (Hansel). A radiocarbon chronology of lake level history for the Lake Michigan Basin over the past 15,000 RCYBP has been prepared on the basis of detailed stratigraphic studies of deposits in the southern Lake Michigan area. Approximately 50 radiocarbon dates on materials collected from Lake Michigan Basin shoreline deposits have been processed in the past 48 months by the ISGS Radiocarbon Lab. These data have made possible an increasingly detailed and revised lake history reconstruction.

Services to Shoreline Residents and Communities

Illinois Capital Development Board and Waukegan Port Authority. In 1984 the Illinois Capital Development Board asked the ISGS to inspect a deteriorating, newly built breakwater at Waukegan and develop a mitigation plan. After numerous conferences, site inspections, underwater inspections and reports, a final report has been presented to CDB and the Waukegan Port Authority. A multi-agency and contractor conference reviewed the report and asked that the Survey continue inspections and plan a geophysical field study of the breakwater.

Wilmette Langdon Park-US Corps of Engineers Studies. At the request of the Wilmette Park District, Collinson examined Langdon Park and Corps of Engineers plans for building an artificial beach. Collinson reported that beach use is no longer appropriate and that the small park is in danger of destruction. A major protective structure was recommended.

Glencoe Shore Zoning Liabilities. Mayor Elizabeth Warren has requested a study of a shore property for which a legal building permit and subdivision permit had been granted by the village. The study is aimed at determining the extent of the possibility that the property will structurally fail.

Sheridan Road Condo and Coop Apartment Owners Association. The Association has asked for technical support in obtaining improved shore protection. A site conference was held in late March 1986.

Rivers and Backwater Lake Research

The Des Plaines River Wetland Demonstration Project (McKenna, Bery, and J. Miller). In June 1985, a study funded by Wetlands Research, Inc. was initiated to determine the feasibility of contructing a riverine wetland within the floodplain of the Des Plaines River in Lake County, Illinois. Preliminary work investigated the geology, engineering properties of the materials and site, and groundwater hydrology as well as the stability and geochemistry of the Des Plaines River within the boundaries of the proposed wetland site. A report discussing the results of this study was prepared and published by Wetlands Research, Inc. A second proposal for geomorphic monitoring of the Des Plaines River has also been submitted to Wetlands Research, Inc.

Geology and Hydrogeology of Heron Pond, Johnson County, Illinois (Bery, Morse, and Stohr). Part of a larger project by the Water Survey to establish a hydrologic plan for the entire Cache River Basin, the goal of this study is to provide the information necessary to save Heron Pond, a Nature Preserve, from destruction by the encroaching Cache River. About 40 to 70 feet separate the cypress-studded pond from the outer bend of a meander of the Cache River. Only 8 to 11 feet of alluvium lie over bedrock between the pond and the river, offering little resistance to the erosion of the side-cutting river. Several borings have been made, and samples of the alluvium have been collected to determine the nature and extent of the unit and the depth to bedrock. Several piezometers have been installed to determine the groundwater gradient between the pond and the river, and to try to determine groundwater movement through the bottom of the pond. Engineering tests for grain size and erodability of the alluvium will yield important data for the design of artificial protection for this important wetland preserve. The project is partially funded by the Illinois Department of Conservation.

Sedimentation Rate Studies in Lakes Using ^{137}Cs and ^{210}Pb (Cahill and Autrey). High sedimentation rates in some Illinois lakes quickly degrade water quality and may reduce the useful lives of these lakes as water supplies. The results of radiometric dating at 13 locations were presented in a paper for the International Symposium on Nuclear Analytical Chemistry. The sedimentation rates ranged from 0.7 to 3.6 cm/yr. Additional sampling was conducted on Peoria Lake in 1985. The results from ^{137}Cs and ^{210}Pb agreed well with a bathymetric survey that was conducted concurrently by the State Water Survey.

HYDROGEOLOGY INVESTIGATIONS

Groundwater Geology

Freshwater Resources of Basal Pennsylvanian Sandstones in Southwestern Illinois (Poole). This study delineated areas of basal Pennsylvanian sandstone containing groundwater of acceptable chemical quality, determined general trends in water chemistry and their possible relationship to hydrologic and geologic parameters, and established baseline data for future management and planning. It was found that basal Pennsylvanian sandstones constitute a significant, relatively undeveloped aquifer system in southwestern Illinois. A detailed study of the extent and quality of the sandstone water resources over the region has not previously been available, and increasing development of the sandstone water resources by rural users and some communities in recent years indicated that this report on freshwater resources is needed by future water-resource developers and managers.

Irrigation Potential and Impacts (P. Reed, McKenna, and J. Gilkeson). The Geological, Water, and Natural History Surveys are cooperating in a project to develop an irrigation prediction model for Illinois. The area chosen for study is about 1,500 square miles in the Mahomet Valley region of east-central Illinois and includes the Arrowsmith, Gibson City, LeRoy, Mahomet, Maroa, and Monticello Quadrangles. The Geological Survey will provide a geologic framework and define aquifers capable of supplying water for small to large scale irrigation systems.

Groundwater Geochemistry

Environmental Effects of Oil Field Brines (McKenna, Hensel, Steele, Whitaker, E. C. Smith, Poole, Laymon; and Carbet, State Water and Natural History Surveys). The Department of Energy and Natural Resources is funding a reconnaissance study to assess the effects of past and present oil production practices on the soil, water, and biotic resources of an area of southeastern Clay County. Geophysical and photo-geologic techniques will be used to identify sources of the problems revealed in the resource inventory. Since the occurrence of saline water may either be natural or the result of brine disposal, the chemical composition of the salt water will be analyzed to determine the source of the salts. An additional objective of this study is to

improve our ability to estimate potential impacts within other oil-producing regions of Illinois.

Groundwater Characterization of the Rockford Area (Berg; and Wehrmann and LeSeur, Water Survey). The purpose of this study, funded through the HWRIC jointly to the ISGS and ISWS, is to characterize the quality of groundwater in an area extremely susceptible to contamination. The role of the ISGS is to identify geologic materials within the Rock River Valley and establish lines of cross section to verify continuity of materials. This information is needed to evaluate the zones from which groundwater samples will be taken for eventual analyses of groundwater quality. Numerous aquitards are present in the valley; groundwater quality could differ above and below the aquitards. The Water Survey is performing extensive chemical analyses of the groundwater and establishing lines of groundwater flow. This study will be completed by July 1986.

Groundwater-Geophysics Studies

Hydrogeological and Geophysical Investigation of Groundwater Resources in Kane County (R. Gilkeson, Laymon, and Heigold). This ISGS-ISWS investigation funded by the county was initiated in 1983 (1) to evaluate groundwater resources in the glacial drift (sand and gravel) aquifers and the shallow dolomite bedrock aquifers of Kane County, and (2) to provide information essential to the management and protection of groundwater resources in the county. Two geophysical methods (seismic refraction and electrical earth resistivity) were used by ISGS staff to define the regional distribution of significant glacial drift aquifers in the county. The regional information is being used in a new program that will guide communities in developing groundwater supplies from sand and gravel aquifers. The new program is supported with funds from the communities and includes application of surface geophysics to locate test borings; geologic descriptions and sieve analysis of samples collected from the borings; downhole geophysics to define aquifer properties; the design of test wells; and the supervision of pump tests. The communities who have joined in this program include Aurora, Montgomery, Geneva, and Batavia.

Renewable Energy Resources in Illinois (Larson). The Geological Survey is participating with the Water Survey and the Natural History Survey in the Board-funded investigation of the renewable energy resources in Illinois. An important class of renewable energy technologies is geothermal energy systems. One type of system, the geothermal heat pump, is being commercially installed in Illinois for domestic and light-duty industrial space heating and air conditioning. However, the basic physical properties of thermal conductivity and diffusivity are not known for Illinois soils. Soil samples have been collected from across the state and are being analyzed for their thermal properties. The results will be incorporated into the statewide Geographic Information System so that maps can be prepared to show the range of thermal properties of soils in the state.

Assistance to Six Small Water-Short Communities in Illinois: Surficial Elecrical Earth Resistivity Surveys (Poole). Most Illinois communities that experience water shortages due to marginal or deficient supplies are located in the central portion of the state. In this study, six small central Illinois communities that experienced water supply problems during the drought of 1976-77 were selected for an electrical earth resistivity (EER) survey program as an aid to siting new municipal wells. The six communities were chosen on the basis of a history of past shortages, estimated future water demand, and the possiblity of obtaining a greater water supply from the glacial drift. Information available on the geologic framework of each study area was used in conjunction with the EER data to delineate favorable sites for test drilling.

Service Activities

Groundwater Geology Reports and Electrical Earth Resistivity Surveys (Staff). Letter reports on groundwater geologic conditions are prepared at the request of citizens, industry, public water supply systems, and governmental agencies to provide information in the siting and development of new and supplemental water supply wells. Electrical earth resistivity (EER) surveys are conducted upon requests for well sites at which a test well failed to obtain an adequate water supply. The EER surveys supplement the information summarized in the geologic report. In addition, numerous requests for general geologic information are answered.

During 1985-86, 736 letters, reports, and technical letters were prepared.

Groundwater Possibilities Reports		102
Pubic water supplies	27	
Farms and rural residences	53	
Irrigation	16	
Industrial	6	
EER Surveys		40
Farms and rural residences	28	
Public water supplies	8	
Irrigation	2	
Oil field brine definition	2	
General Technical Information		578
Miscellaneous Letters		16
Sieve analysis of well cuttings (14 wells)		
Study of samples from problem wells (2 wells)		

These statistics do not include information provided by staff during the year in response to approximately 950 telephone requests and to 130 visitors who came to the Survey seeking help on specific problems from the staff of the Groundwater Section.

Other Groundwater Studies and Projects

Aquifer Assessment Program Plan (T. Johnson and Larson). The Groundwater Section at the Geological Survey is cooperating with the State Water Survey in the development of a Groundwater Resources Assessment Plan as part of the Aquifer Assessment Program. Based on meetings between the staff of the two Surveys the first draft of the plan has been prepared. This plan will address the need for an integrated program for groundwater resource assessment in Illinois.

Technical Assistance Program (McKenna, E. C. Smith, J. Gilkeson, and Mushrush). This Department of Energy and Natural Resources funded project includes technical assistance and response activities in conjunction with the Water Use Act of 1983 and efforts to develop an improved data management system for groundwater information. The Groundwater Section has evaluated the hydrogeologic setting of 87 proposed high-capacity wells for possible adverse effects on nearby wells. A microcomputer-based data management system that allows retrieval of information on well location, depth of use, and target aquifer has been developed. This system will include data from Water Use Act requests, groundwater potential reports, and electrical earth resistivity studies.

Public Groundwater Supplies in Illinois. Survey geologists contributed reports on the geology and stratigraphy of aquifer units for the Du Page, Livingston, and Knox County parts of the Illinois State Water Survey Bulletin 60. These comprehensive reports chronicle the production of individual wells and aquifers and the effects of pumpage on water supplies. The reports delineate trends that help municipalities plan to maintain water supplies and quality.

EARTH HAZARDS AND ENGINEERING GEOLOGY

Landslides

Landslide in Iroquois County (Bradford, Killey, and Krumm). At the request of a Belmont Township trustee in Iroquois County, Survey staff investigated a landslide causing damage and hazardous conditions to drivers along a county road. The landslide is located adjacent to Sugar Creek about one mile south of Watseka. Instruments were installed at the slide to monitor the sliding mechanism and to provide geotechnical information for design treatment. The instruments will help determine the position of the failure plane and document earth movements. Periodically, reports about the study are made to the county. A scientific report of this study is being prepared for presentation at the 1986 meeting of the North-Central Section of the Geological Society of America.

Landslides at Chester, Illinois (DuMontelle, Killey, and Krumm). Landslides in and around Chester, Illinois, have damaged houses, roads, and utilities. After spending more than $100,000 to repair a section of

road, representatives of Region II of the Illinois Emergency Services and Disaster Agency (ESDA) arranged for staff from ISGS to meet with Mayor Dierkson, one of the city alderman, and the street commissioner to review and comment on the problem. The landslides occur naturally, caused by the geology and climate of the region. A letter report was prepared for ESDA and the Mayor describing the mechanism and probable cause of the problems. We indicated that Chester would benefit a great deal if the geologic factors and the areal extent of the landslides were better defined so that unstable areas could be avoided. Robin Warren, graduate student at the University of Illinois, has selected the Chester site as a thesis problem and will be starting work there this summer.

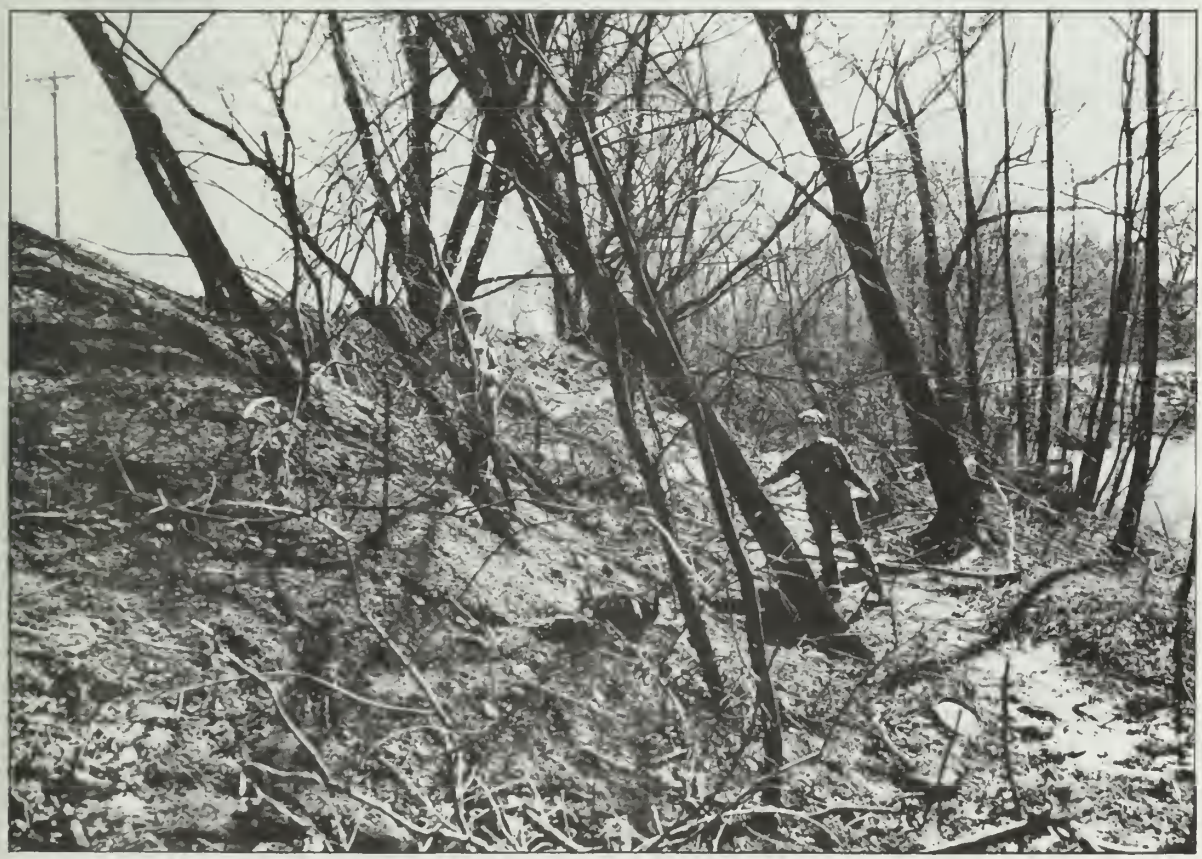
Mine Subsidence Research

Illinois Mine Subsidence Research Program (DuMontelle, Bauer, Gefell, and Trent). Organized in 1985 to coordinate research and develop guidelines that safeguard the interests of the mining and farming industries, this 5-year program is designed to study the effects of subsidence caused by coal mining beneath prime farmland and to prepare guidelines to eliminate or mitigate problems. The program is supported by both federal and state funding gained through the efforts of the Illinois Coal Association and the Illinois Farm Bureau. Leadership of the technical program is provided by the Illinois State Geological Survey with the assistance of scientists from Southern Illinois University at Carbondale, the University of Illinois, the Illinois Department of Mines and Minerals, and the U.S. Bureau of Mines. During the first year, investigations were conducted to evaluate the in-place strength of mine floor materials at two mines, initial surveys of crop damage resulting from subsidence were completed, and arrangements were made for overburden studies over an active high-extraction mining site. Database management systems are being tested and developed. A brochure describing the program was published and Technical and Advisory Board Meetings have been held.

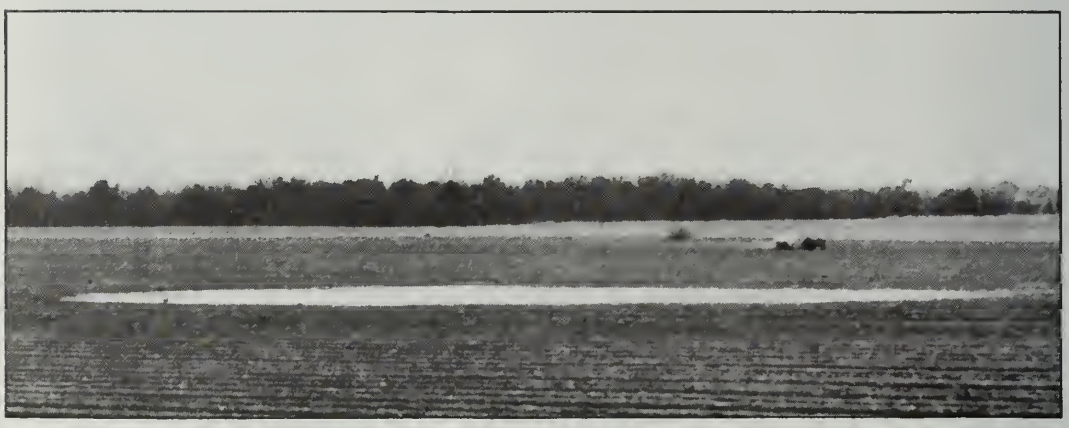
Application of Time Domain Reflectometry to Subsidence Monitoring (Bauer). Northwestern University and the ISGS are investigating the use of a coaxial cable testing device and coaxial cables grouted in boreholes to sense subsidence movement above active coal mines. This electrical response method is called time domain reflectometry (TDR). For many years, TDR has been used successfully in the communications industry to locate breaks and damaged sections of telephone cable. The IMSRP high-extraction mining site used to investigate overburden movement will be used also to compare TDR surveying methods with conventional geotechnical methods.

Mine Subsidence Insurance Fund Claims Database (Bradford, DuMontelle, Hindman, Cooper, and Junkins). More than 2,000 claims, including all current claims, are now recorded in the database for the Mine Subsidence Insurance Fund Claims Database in the DENR Prime Computer. This system will continue to be used to develop maps showing the spatial distribution of claims in Illinois using the Survey's Geographical Information System. However, to provide better access and

Geologists, Myrna M. Killey and Susan Carol Bradford, investigate a crack near the main scarp of a landslide in Iroquois County. The road in the background is threatened by the landslide; the gravel mounds between the people and the road represent attempts by a township highway commissioner to keep the shoulder of the road high enough to be safe for passing motorists.



Myrna M. Killey points out one of many trees tilted by a landslide in Iroquois County.



Not all ponding in fields is connected with coal-mine subsidence. Natural depressions are common. Illinois' broad areas of flat terrain are very sensitive to the variable midwestern climate and to differences in elevation. In fact, much of this land had to be tiled and drained to farm the rich soil.

Floor heaving in a coal mine is caused by the load from the overburden rocks pushing the coal pillars into a weak floor.

communication with the office for the Illinois Mine Subsidence Insurance Fund, these data will be transferred to a microcomputer. The ISGS menu-driven software developed to aid authorized users of the directory will be copyrighted. Survey staff will participate with the manager and a consultant for the Fund to present findings of the program at a national workshop--Subsidence Due to Underground Mining--held in June 1986 in Morgantown, West Virginia, and sponsored by the Office of Surface Mining and West Virginia University. Our contract with the Mine Subsidence Insurance Fund may be extended for another year beginning June 15, 1986.

Maps and Mapping

Resolution of the Illinois/Kentucky Boundary Dispute (DuMontelle and Scoggin). In 1792 the boundary between Illinois and Kentucky was defined by Congress as the low-water level position on the northwest shore of the Ohio River. Because no maps were available in 1792 and the position was not monumented, both states have claimed right to parts of the river. Representatives of the Survey, the Illinois Department of Tranportation, and the Illinois Department of Conservation met with John Brunsman, Assistant Illinois Attorney General, to review options in proceeding with a friendly action to the Supreme Court to resolve the boundary dispute. In June, using a map developed from the earliest survey of the U.S. Corps of Engineers and new technology in digitizing and map making, Illinois will make a boundary proposal to Kentucky. The Survey has offered to serve as a reviewer in this process and to act as a repository for the information within the DENR geographical information system. The Survey will also provide the U.S. Geological Survey with the agreed upon digitized boundary to be shown on all new maps constructed for Illinois.

Satellite Image Map of Illinois (Stohr and DuMontelle). Within 10 days after issuing the first false color satellite map of Illinois, the Survey received orders for more than 8,000 copies. Nearly 15,000 maps have now been distributed. The 36 by 52 inch map was prepared for printing by the Northern Illinois University Laboratory for Cartographic and Spatial Analysis and the U.S. Geological Survey; 13 Landsat Thematic Mapper film images that covered the state were mosaicked using a photomechanical method developed by Alden Warren of the U.S. Geological Survey. A second satellite image map showing the northeastern part of Illinois at a scale of 1:200,000 was released in March.

Activities of the Illinois Affiliate Office of the National Cartographic Information Center (Scoggin, DuMontelle, and Stohr). The Illinois Affiliate Office of the National Cartographic Information Center (NCIC) is making plans to celebrate in 1987 the first-time coverage of Illinois with 1:24,000-scale 7.5-minute topographic maps. Fifty-two maps were released for distribution this year and the 36 remaining quadrangles in this series are expected to be completed late in 1986 or early in 1987.

Our free-distribution program sends each new map to local and state officials. This year, separate mailings were made for 115 new 7.5-minute maps, 5 new 30° by 60° quadrangles, and one county map.

Current objectives of the Illinois topographic and planimetric mapping program also includes revising the 1:500,000-scale Illinois base map and publication of approximately 30 1:100,000-scale county maps. The NCIC affiliate is preparing a new USGS Index to Topographic Maps of Illinois to show the complete coverage of 7.5-minute quadrangles.

The affiliate received more than 500 telephone inquiries and met more than 170 visitors seeking geodetic control data and information about cartography.

Rock and Soil Mechanics

Distress Cracking of Concrete Highway Pavement (Bauer, Baxter, Masters, and Hughes). Distress cracking is a major problem for concrete highways in Illinois. In a cooperative study with the Illinois Department of Transportation to develop a simple field procedure for determining the susceptibility of aggregate to cracking caused by freezing and thawing, we are investigating the suitability of field and laboratory testing methods. Shore and Rockwell hardness testing results will be compared with other common field tests such as point-load index, indirect tensile strength, and compressive and shear wave velocity. These tests will be studied and correlated to the freeze-thaw susceptibility of aggregate samples as shown by percent strain elongation.

Soil Pressure on Basement Walls (Bradford and DuMontelle). The Survey and the University of Illinois Small Homes Council are working together to develop a 3-year project to study the cause and nature of soil pressures against basement walls. Preliminary investigations indicate lateral pressure from expanding soils in Illinois severely damage and sometimes collapse basement walls in homes. The study will include a survey of homes in Champaign County, field sampling at selected sites, laboratory analysis, and finally evaluation of these findings to design a full-scale laboratory experiment. This experiment will measure lateral pressures as they increase against the wall and enable researchers to better design walls and to evaluate other mitigation procedures.

Review of Plans for Mining Coal (Bauer). At the request of the Illinois Department of Mines and Minerals, plans for mining coal are analyzed to determine the stability of coal pillars and underclay (floor) materials during and after mining. Three mine designs were reviewed this year utilizing a series of five computer programs written by Robert A. Bauer (Coal Section). An important part of the analysis is based on a comparison between reported strengths of the rock and strengths of similar rock units found in our ISGS physical properties database.

Activities of the Rock Mechanics Laboratory (Bauer, Gefell, Hasek, and Su). Rock samples from two prospective coal mine sites and one operating mine were tested to determine strength characteristics. Strength testing of cores from a sandstone channel at one of the mines showed that the rock strength properties of the sandstone in the channel were no different from the shale roof found in other parts of the mine. This assured the company that they could mine through the channels using existing equipment. Rock strength information was supplied to the Illinois Department of Transportation, four private consulting firms, three coal companies, two oil companies, the U.S. Geological Survey, the Illinois Department of Mines and Minerals, and Los Alamos National Laboratory.

Activities of the Inter-Survey Geotechnical Laboratory (M. Miller, Roeper, Westcott, and Chibani). The Inter-Survey Geotechnical Laboratory processed 6,600 samples since May 1, 1985. These samples were submitted from a number of different projects including irrigation studies, the Lake Peoria evaluation project, the Des Plaines River Wetlands project, the Lake Springfield Drainage study, the Quincy Bay project as well as the monitoring networks maintained by the Illinois State Water Survey and the U.S. Geological Survey. The laboratory also supervised the Surveys' driller and drilling operations. Projects mainly included the installation of surficial instruments and sampling surficial materials. The rig was also used to diamond drill Pennsylvanian sediments at one site in southern Illinois.

Other Research and Service

Geotechnical Information for Prospective Factory Sites Identified by the Department of Commerce and Community Affairs (DCCA) (Bradford, DuMontelle, Poole, and Killey). The Survey provided information about construction conditions and availability of water at nine prospective factory sites in Champaign, Jefferson, Kankakee, Madison, Putnam, St. Clair, Sangamon, and Will Counties. DCCA will keep the information on file so that it can match the requirements of site developers with appropriate sites.

Investigations of the Hazardous-Waste Landfill at Wilsonville, Macoupin County (Stohr, Su, and DuMontelle). Survey field and laboratory engineering geology studies at the hazardous-waste landfill at Wilsonville are now complete. These determined the physical properities of soil materials at the site, included surveys to determine whether mine subsidence could have contributed to the failure of the site, and evaluated the performance of the trench covers constructed at the site. Final reports are being prepared and reviewed.

Proposed Waste Disposal Chambers at Ottawa (Bauer and DuMontelle). Pioneer Processing, Inc. has proposed to build concrete vaults to store wastes near Ottawa, Illinois. The foundations of these structures will bear on bedrock units 60 to 70 feet below ground surface. At the company's request we have provided strength values of specific rock units from existing data. Additional site specific design and strength determinations may be made in the future.

GENERAL AND BASIC RESEARCH AND SERVICES

W. John Nelson, Coal Section, examines strata of the Abbott Formation (Pennsylvanian) in the Stonefort Quadrangle, Pope County: COGEOMAP project.

GENERAL AND BASIC RESEARCH

GENERAL

Major Equipment Acquisition

In the long history of the Scientific Surveys, the major equipment provisions contained in the 1986 "Build Illinois" legislation will clearly become a landmark--one highlighted by the strong support of our Board of Natural Resources and Conservation. As a result, $1 million worth of equipment has already been approved for delivery to the three Surveys in FY86. Moreover, an additional $2 million has been committed this year for delivery of major equipment in FY87 following reappropriation of the funds by the legislature.

Finally, according to the Build Illinois legislation, an additional $2 million is scheduled for appropriation by the legislature for equipment purchases in FY87.

GEOLOGIC MAPPING

Bedrock Mapping

Cooperative Geologic Mapping Program with the U.S. Geological Survey in Southern Illinois (COGEOMAP) (Damberger, Danner, Devera, Jacobson, Lumm, Nelson, Trask, and Weibel). The Cooperative agreement with the U.S. Geological Survey to geologically map 15 7.5-minute quadrangles along the southern closure of the Illinois Basin was extended for a second year (FY87). The area to be mapped includes the exposed lower part of the coal-bearing Pennsylvanian sequence, below the well-known coals of the Illinois Basin. Any coals contained in the sequence will have a high heating value and be potentially low in sulfur content due to the mostly nonmarine origin of the rock sequence. The area to be mapped is crossed by numerous faults that may be mineralized in a manner similar to the faults of the fluorspar district to the southeast. The recognition of previously unknown structures or the reinterpretation of known ones may provide new incentives for oil and gas exploration.

Publication of the Shawneetown, Equality, and Rudement 7.5-Minute Geologic Quadrangles (Lumm, Nelson, Damberger, and Cartographic Group of Northern Illinois University). These three quadrangles were mapped by Nelson and Lumm with the assistance of NRC, which provided funds to study the structural geology of southeastern Illinois (between 1981 and 1984). The geologic maps were compiled in draft form and after review turned over to the Cartographic Group of Northern Illinois University, under Dr. Dahlberg's leadership, for artwork, final drafting, layout, scribing, text setting, and color negatives. This work will be completed by early spring and the maps will be printed and published by mid-1986. The request for bids to print the maps has been submitted to the Springfield offices.

Creal Springs and Eddyville Quadrangles (Jacobson, Trask, Nelson, Lumm, Devera, Weibel, and Danner). Field work on these two quadrangles is almost complete. Drafts of the geologic maps, cross sections, stratigraphic column, and legend were completed late in 1985 and early in 1986. Field checking will be completed by June. Final drafts of the two maps will be submitted to the U.S. Geological Survey for review.

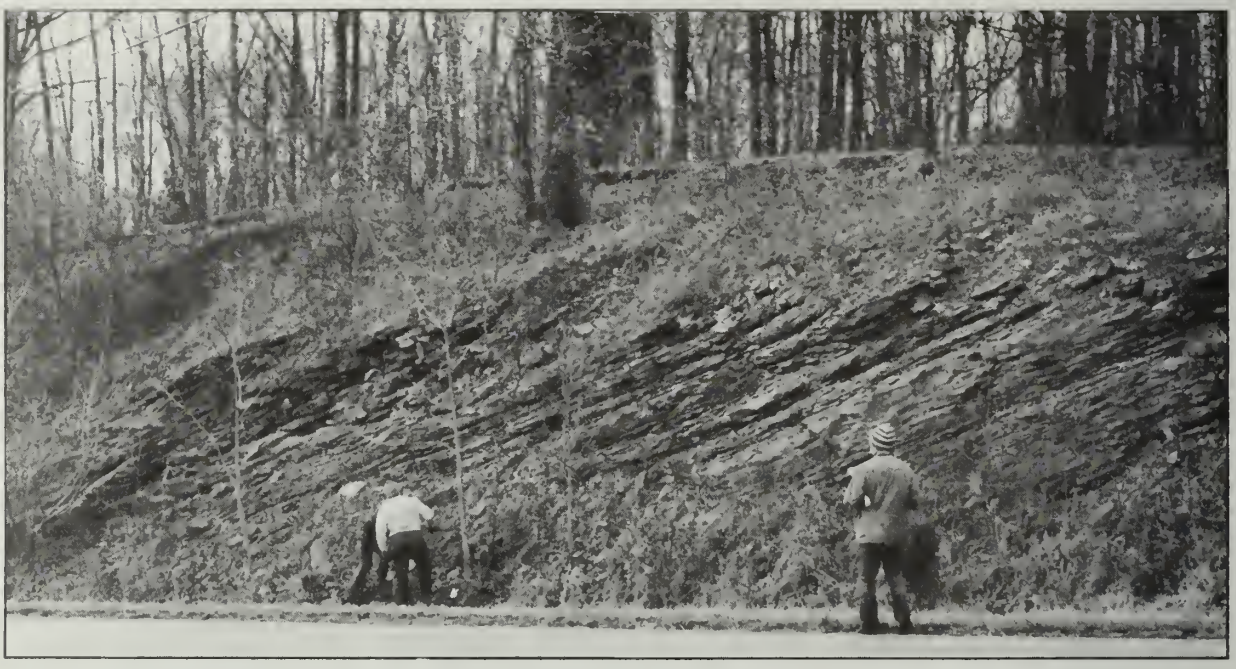
The detailed mapping leads to greatly improved knowledge of coal seam exposures, including several coals not previously recognized, of fault traces, of the regional structure, and of the stratigraphy and depositional environments of the lower Pennsylvanian strata.

Contract funds were used to drill eight shallow stratigraphic test holes, four on the Creal Springs quadrangle and four on the Eddyville quadrangle. The drill sites were selected to provide maximum information in areas of poorly exposed stratigraphy. The drill program was completed in November 1985. The recovered core and downhole geophysical logs have proven valuable aids in compiling the maps.

A cooperative agreement with Dr. Steven Esling of the Department of Geology at Southern Illinois University at Carbondale provides for geologic mapping of the surficial (Quaternary) earth materials on the Creal Springs and Eddyville quadrangles. A total of 56 holes were drilled with the Survey's Giddings drill rig on the two quadrangles (29 on Creal Springs, 27 on Eddyville) to supplement field work and library research. Draft maps that show the distribution of the surficial materials were completed early in 1986. The uplands have the most complete section: 3 to 4.5 feet of Peoria Loess above 3 to 4 feet of Roxana Silt, which rests on 0.5 to 3 feet of residuum. Field and laboratory work is being carried out by two graduate students, Matt Riggs and Beth Henderson, as part of their masters' theses. Another cooperative agreement was reached with Dr. Larry Malinconico, also of SIU, to map the gravity and magnetic fields of the two quadrangles on a closely spaced grid. The Creal Springs quadrangle was completely mapped by Steve Brennecke, whose findings have helped interpret some structures. Final reports are expected by late summer.

Stonefort, Glendale, and Waltersburg Quadrangles (Nelson, Lumm, Jacobson, Trask, Devera, and Weibel). Active field work currently concentrates on these three quadrangles, which are in various stages of progress. The Stonefort quadrangle is located between the almost completed Creal Springs and Eddyville quadrangles, and an effort will be made to complete most of the field work on it by June. The Waltersburg quadrangle was partially mapped more than 20 years ago by James W. Baxter (Industrial Minerals Section) during mapping of the Illinois fluorspar district. Current mapping concentrates on the areas of lower Pennsylvanian strata. The Glendale quadrangle is the least advanced.

Mapping the surficial materials and the magnetic and gravity fields will be a cooperative program involving Drs. Esling and Malinconico of SIU.



Heinz H. Damberger, Head of the Coal Section, and Russell J. Jacobson, Coal Geologist, examine tilted strata of the New Burnside Structure for the COGEOMAP project: Creal Springs Quadrangle, Johnson County.

Dust storm: soil erosion as the source of eolian (windblown) deposits. On this day, wind speed was 30 to 40 m.p.h. with gusts up to 60 m.p.h. Route 47, Kane County.

Surficial Geology

Landscape-Scale Interactions in Vermilion River Basin (Follmer and Stanke). Studies have been initiated to evaluate the geological factors that control stream quality in the Salt Fork and Middle Fork of the Vermilion River between Champaign and Danville. A relationship has been found that indicates the biological condition of stream water is a function of stream gradient. River segments with low gradients suffer the greatest deterioration during low flow conditions. Geological factors that cause different stream gradients have been identified and are the subject of continuing research. The project is supported by ENR Contract EH24.

Edwards River Valley Soil Geomorphology (Follmer; Tandarich and Darmody, University of Illinois). This study was initiated to explain an unusual pattern of sandy soils along the Edwards River Valley of Mercer county. The valley has an asymmetrical cross section with a series of steps. Eolian sand deposits, once thought to be outwash, cover most of the valley sides in an irregular pattern. A highly complex erosional and depositional history explains much of the soil pattern. The soil and geology patterns are very important for agricultural land-use management, determining pollution potential, and protecting water resources.

The Evolution of Pedologic and Geologic Profile Concepts in the Midcontinent, USA (Follmer; Tandarich and Darmody, University of Illinois). The concepts of the weathering profile and soil profile have experienced a long history of development. The C horizon concepts have not yet been worked out to a consensus among geologists and pedologists. A detailed explanation of a genetic-based classification for subdivisions of the C horizon has been developed to be compatible with concepts of the main body of soils.

Recognition of Paleosols in the Field (Follmer). A committee of the International Soil Science Society has asked Leon R. Follmer to prepare a chapter on the recognition of paleosols in the field for a Handbook on the Identification of Paleosols. Paleosols are important in the study of old and buried landscapes. They are used to identify geologic units in stratigraphic classification. Paleosols at shallow depths are very important in the control of physical and chemical characteristics of soils on the present land surface.

Geologic Materials to a Depth of 50 Feet in Illinois (Berg, Kempton, J. Miller, and McKay). A statewide stack-unit map showing the sequence of geologic materials to a depth of 50 feet is nearly complete and will be published as four plates (scale, 1:250,000) included in a short circular. This information describing more than 5,200 map units is now in the Survey's GIS System. This map is the basic geologic map for land-use and resource-based land-use planning in Illinois.

Analysis, Comparison, and Interpretation of Soil Properties by Nuclear and Gravimetric Methods (J. Gilkeson, McKenna, and M. Miller). Soil density and moisture content were evaluated by nuclear and gravimetric methods at six locations in Champaign and Piatt Counties. An analysis of the results of the two methods was done to determine whether nuclear methods yield accurate soil property data and what can be done to increase the accuracy of nuclear surveys.

GEOPHYSICAL INVESTIGATIONS

COCORP Proposal

The Illinois State Geological Survey has submitted a proposal to the Consortium for Continental Reflection Profiling (COCORP) requesting acquisition of deep seismic reflection data in southern Illinois.

More than 300 miles of intersecting seismic reflection traverses have been selected. These traverses cross geologic structures and geophysical anomalies that are critical to understanding the tectonic evolution of the midcontinent.

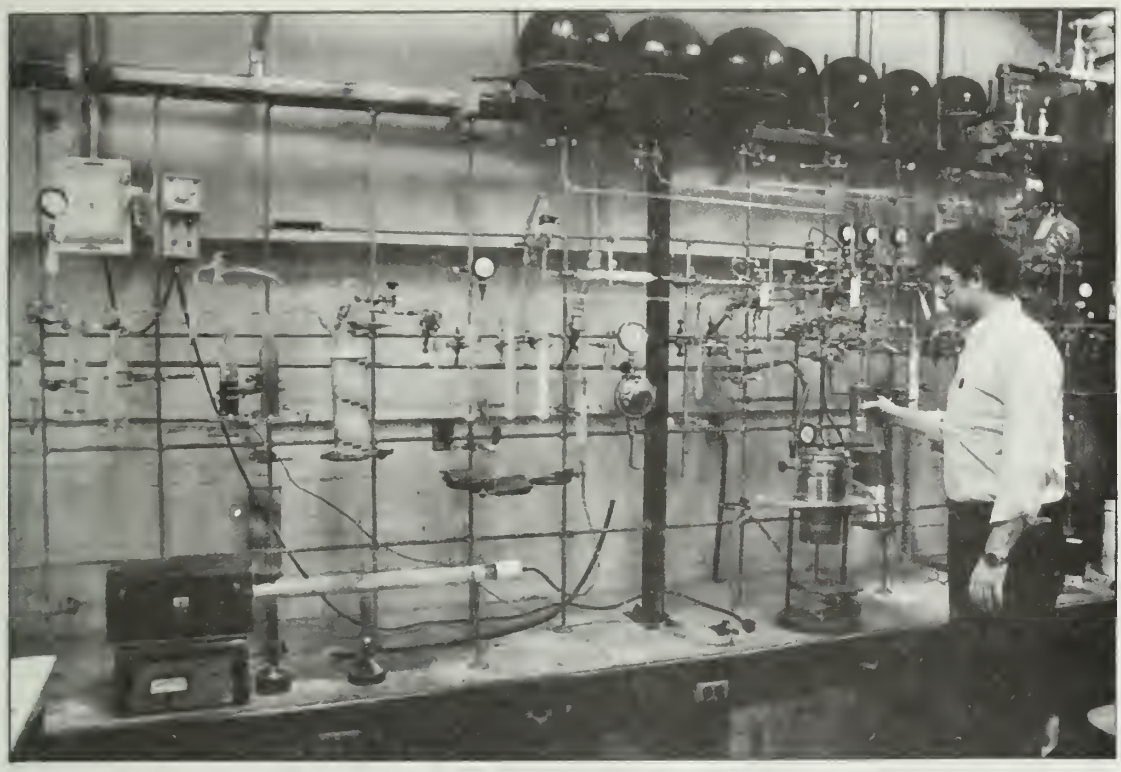
In addition, these deep seismic reflection data would provide information about the lower crust and upper mantle of the earth--about which only speculation has been possible.

GEOCHEMICAL INVESTIGATIONS

Isotope Geochemistry

Radiocarbon Dating (Liu, Fisher, and Coleman). During the past year, radiocarbon ages were determined for 187 geological and archeological samples. An equal number of $^{13}C/^{12}C$ determinations were performed during the same period for isotopic fractionation corrections. Approximately 55 percent of the samples analyzed were paid for with funds from sources outside the Survey. Despite repeated equipment breakdowns, a 7-days-per-week operational schedule carried out by laboratory personnel has enabled an increase in productivity by 40 percent compared to the previous year (187 samples vs 130 samples). Funding for a new liquid scintillation spectrometer has been included in the budget of Governor Thompson's "Build Illinois" Program. Acquisition of this instrument is imperative as the older of our two counters (approximately 20 years old) is now broken. Because of the obsolescence of the components, it cannot be repaired.

Three ISGS date lists have been accepted for publication by "Radiocarbon." Lists VIII and IX will be published in Radiocarbon, Vol. 28, No. 1. ISGS date list X will be published in Vol. 28, No. 2.



This chemical system is used to prepare and concentrate the naturally occurring, radioactive isotope carbon-14, found in geologic and anthropologic samples as old as 50,000 years B.P.

Scintillations (flashes of light) caused by radioactive disintegrations of carbon-14 in benzene (with phosphor) are counted in this liquid scintillation spectrometer. In this way, the age of geologic specimens (such as soils, wood, and shells) can be measured. For very old samples (50,000 years B.P.), it is necessary to count a specimen for several days.

Stable Isotope Ratios as Naturally Occurring Tracers in the Aquaculture Food Web (Morin, Coleman, and Liu). This joint project with the Natural History Survey, funded by the United States-Israel Binational Agricultural Research Development Fund (BARD), involves the use of natural isotope tracers to evaluate the significance of the available food in an aquaculture system and the effectiveness of certain agricultural wastes as fish foods.

Experiments in 1985 and 1986 were two-fold in purpose. First, quantities of isotopically distinct algae ($^{13}C_{PDB}$ = -53°/oo) were produced for use in INHS aquaculture studies. Second, it was shown that different algae species grown under similar conditions may develop drastically different carbon isotopic compositions. All available evidence points to differences in growth rates being the most influential parameter in the determination of carbon isotopic composition in algae grown under similar conditions of CO_2 availability. The final project report is now in preparation and should be completed by April 1.

Assessment of Causes for Oxygen Depletion at the Pittsfield Compressed Air Energy Storage Site (CAES) (Risatti, Krapac, Brower, Griffin, Dickerson, and Hughes). Geologic formations are being used to store air under pressure for later use by the electrical generation industries at the Pittsfield, IL CAEA facility (Yakley Field). Stored in a St. Peter Sandstone reservoir, the injected air showed a significant depletion in oxygen content after 5 to 9 months of residence. The problem is that the air is withdrawn and mixed with gas to fuel gas turbines, and its loss of oxygen could impair the efficiency of the turbines.

Detailed and carefully controlled quantitative analyses were made of air composition, carbon isotopic composition of carbon dioxide, and bacterial content of gas, water, and particulate matter in the water. The results indicate that oxygen depletion and carbon dioxide enrichment of reservoir air are not due to microbiological activity. Oxygen depletion is probably a product of chemical oxidation-reduction reactions with minerals in the reservoir rocks. Carbon dioxide enrichment is related to outgassing of aquifer water as oxygen depletion occurs in the reservoir gas.

CLAY MINERALOGY

Mechanisms of Layer Silicate Weathering by Plants (Hughes). Research during the past few years on Pleistocene and Pennsylvanian-aged soils has shown that plant-induced changes in mineral composition are very common. Since plants can alter minerals at rates several times greater than those of inorganic processes, and since plants can selectively force dissolution of mineral constituents, a study has been started to investigate the types of mechanisms and rate of alteration associated with different types of plants. If early results are promising, the study may be expanded to include the effects of bottom-rooted aquatic plants on substrate mineralogy; the effects of organisms

such as worms on sediments; and the degree of alteration expected from each phase of the growth, decay, and coalification of plants.

Mineralogy, Mixed-Layer Composition, and Illite Polytypes of Paleozoic Rocks of Illinois (Hughes, Glass, Austin, Warren, and J. Fox). This research is aimed at determining whether individual clay minerals are detrital, diagenetic, or authigenic in each of the Paleozoic strata of Illinois. Upgraded X-ray diffraction (XRD) capabilities are allowing detailed assessments of the illite/smectite clays, the proportion of diagenetic (1M) and detrital (2M) polytypes of illite, and the origin of "1Md" polytypes in these strata. Laboratory equipment is being installed to isolate illite from clay mixtures.

STRATIGRAPHIC INVESTIGATIONS

The Geological Survey has primary responsibility for developing information and reporting on the basic stratigraphic units that underlie the state. Emphasis during the year was on the development of the Illinois Superdeep Drillhole Project and the Sag Basin Studies.

In November, Dennis R. Kolata was appointed Lead Geologist for the newly formed Basin Analysis Task Force. Michael Sargent joined him along with Paul C. Heigold, Mei-In Melissa Chou and Janis D. Treworgy. At the same time the Stratigraphy and Subsurface Section became the Stratigraphy and Surficial Geology Section.

The major activity was the generation of thickness maps for the stratigraphic sequences with special emphasis on the Precambrian surface map, which in February-March underwent entensive revision in the light of new geophysical studies in the rift areas. In Quaternary Stratigraphy, major efforts in the northeasternmost seven counties, included mapping the tills and studying the Illinois Des Plaines Sag Canal drainage area as well as the geomorphology of the Chicago area.

Quaternary Stratigraphy

Applications of Clay Mineral Composition in Quaternary Geology (Glass and Killey). Clay mineral data from 15 counties in west-central Illinois and a two-county area in northeastern Illinois have been analyzed in a project that will integrate 25 years of clay mineral analyses at the Illinois State Geological Survey. The goal is to synthesize the data into a state map of 1:500,000 scale depicting the clay mineral composition of surficial tills. In addition, publications are being prepared on (1) methods and techniques developed for the rapid determination of clay mineral composition, and (2) principles of application of clay mineral analyses for stratigraphic correlation.

The data and state map are important for determining (1) suitability of earth materials for burial and containment of hazardous wastes, (2) distribution of economically recoverable clay resources; (3) areas of expansive soils that cause foundation failures and other engineering

problems during construction and maintenance; and (4) the role of certain clays as contributing factors in the development of landslides.

Use of Clay Mineralogy and Radiocarbon Dating in the Interpretation of Sedimentary Units, Mound City, Illinois (Reed, Masters, and Glass). This subsurface investigation utilizing split-spoon samples, drill samples, and driller's logs was carried out on geotechnical test-borings of the Memphis District, U.S. Army Corps of Engineers' seepage control project. The ISGS ran geophysical logs and studied samples of selected test holes, including radiocarbon dates of two wood samples. Sedimentary units were defined on the basis of lithologic characteristics of samples from 38 borings. The units included Quaternary floodplain and valley-train deposits that are underlain by and contain material derived from nearby Eocene and Paleocene deposits. Information developed from the work was useful to the Corps in their project design specifications, and was helpful for understanding the groundwater system and for evaluating potential construction aggregate resources of the area.

Clay Mineral Classification of the Kellerville Till Member, Western Illinois (Killey and Glass). Clay mineral data suggest that the highly variable clay mineral composition of the Kellerville Till has two causes: glacial depositional processes and post-depositional alteration of clay minerals. Kellerville Till not underlain by the Illinoian deposits is generally of uniform composition. Local entrainment, incorporation, and homogenization of older accretion-gley, till, and bedrock by Kellerville ice produce variable clay mineral compositions.

Ancient Loess Deposits Along the Mississippi River (McKay and Glass; Hajic, University of Illinois). Continued sampling, description, and analysis of Illinoian and older loess deposits has shown that regional correlation is possible. Thermoluminescence dating indicates that the thickest of the Illinoian loess in the subsurface in southwestern Illinois is stratigraphically equivalent to the Loveland Loess of the Missouri and Lower Mississippi Valleys. A newly discovered section along the Mississippi River in Calhoun County, beyond the limit of glaciation, exposes multiple loess deposits, fluvial gravels, and paleosols. Detailed sampling and analysis will allow preliminary correlation to deposits within the glacial sequence.

Chicago Outlet Drainage History (Hansel). The stratigraphic record in the Chicago Outlet was used to reconstruct the history of drainage from the Lake Michigan Basin to the Illinois River Valley. The radiocarbon-dated stratigraphy provides new evidence on the age of outlet downcutting: even during the highest phase when the lake was 60 feet above modern lake level 12,500 years ago, lake level was controlled by the volume of water coming into the lake rather than the threshold altitude of the outlet sill. These findings have important historical implications for the relation between lake level and climatic change.

Quaternary Stratigraphy of the Wedron Formation, Northeastern Illinois (Hansel; and W. H. Johnson, University of Illinois). In 1985, six holes were drilled and numerous exposures were studied to aid in

correlation of lithostratigraphic units of the Wedron Formation and to provide available basic geologic information on the Greater Chicago Area. Stratigraphic correlations proposed by Hansel and Johnson at the 1985 North-Central GSA field trip were revised with respect to new data. The Lemont Drift-Haeger Till Member correlation was further documented.

Glacial Sedimentary Environments of the Wedron Formation (Hansel; and W. H. Johnson, University of Illinois). Study of the sedimentary characteristics of the Wedron Formation is continuing in an attempt to model glacial sedimentary environments and predict the probable relationships among glacial materials deposited during the last ice event in Illinois. Several important Wedron successions have been studied in detail, and lithofacies diagrams, clast fabric diagrams, and summaries of analytical data have been prepared. Applications include groundwater studies, land-use planning, and locating landfills.

Quaternary Evolution of the Illinois-Michigan Canal National Heritage Corridor (Hansel, L. Smith, and Stecyk). Information from current investigations into the Quaternary geology of northeastern Illinois was used to prepare a color brochure on the Ice Age Evolution of the Illinois-Michigan Canal National Heritage corridor for the National Park Service. The brochure focused on the landforms left after the last ice retreat, the use of radiocarbon dates to time the glacial and lake events, and the importance of topography in determining the canal route.

Paleozoic Stratigraphy

Correlation of Middle Ordovician K-bentonite Beds in Eastern North America by Chemical Fingerprinting (J. Frost and Kolata; and W.D. Huff, University of Cincinnati). Middle Ordovician K-bentonites (altered volcanic ash) in the Mississippi Valley contain two widespread beds, the Deicke and Millbrig K-bentonite Beds. Each has a unique chemical fingerprint that can be used to correlate these beds from southeastern Minnesota to southeastern Missouri--a distance of 900 km. These two beds are now being traced on geophysical logs eastward through the Illinois Basin into central Kentucky and Tennessee and into the Appalachian Basin. Approximately 100 K-bentonite samples collected in Alabama, Tennessee, Kentucky, and Virginia are being analyzed for 26 elements by instrumental neutron activation analysis and X-ray fluorescence spectroscopy. Preliminary results suggest it is possible to correlate the Deicke and Millbrig from St. Paul, Minnesota, to Birmingham, Alabama, a distance of 1,300 km. The National Science Foundation is funding this project.

Compendium of Ordovician K-bentonites of North America (Kolata; and W. D. Huff, University of Cincinnati). Most literature about Ordovician K-bentonites in North America discusses the stratigraphic occurrence and/or mineralogy of K-bentonites in limited geographic areas.

Lithostratigraphy and Biostratigraphy of the Everton Dolomite (Sargent and Norby). Precise definition of the Everton Dolomite is important because its base is the boundary between the Tippecanoe and Sauk Sequences and its top is the top of the Knox Dolomite Megagroup. Continued refinements of our understanding of Everton Dolomite indicates it is the only Whiterockian age formation in the Midcontinent. Mapping of Everton thickness shows it generally thickens southward from a pinch-out located near St. Louis in the southwest, Vandalia toward the center, and Lawrenceville in southeastern Illinois. Thickness exceeds 400 feet in an area of about 400 square miles centered near Rend Lake in northern Franklin County. Everton thins to just over 300 feet in Pulaski, Massac, and southern Johnson Counties in extreme southern Illinois.

Age and Origin of Potassic Metasomatism in Ordovician Tuffs of the Upper Mississippi Valley (R. L. Hay, University of Illinois; Mingchou Lee, Case Western Reserve; and Kolata). Tuffs (altered volcanic ash) of the Middle and Late Ordovician age are altered to mixed-layer illite-smectite (I/S) and to K-feldspar in the Upper Mississippi Valley region. Potassium-argon dates indicate formation of the authigenic K-feldspar during the early Devonian and formation of the illite-smectite during early Mississippian time. Oxygen-isotopic composition of the K-feldspar and illite-smectite shows that the two minerals crystallized under different conditions and probably reflect introduction of waters of varying chemistry and temperature. Introduction of these pore waters may have been caused by groundwater movements resulting from recharge in distal areas undergoing tectonic uplift. Results of this on-going research will add to the understanding of ancient fluid movement through Paleozoic sedimentary rocks in the Midcontinent.

Stratigraphic Study of Chicago-Area Silurian Rocks (Mikulic, Norby, and Sargent). This study will review and revise the lithostratigraphic and biostratigraphic framework of Silurian dolomites in northeastern Illinois. These rocks are of special importance to construction engineers and producers of crushed rock. Many quarries have been expanded in recent years, presenting opportunities for new studies. Work thus far has consisted of studying these quarry exposures and processing of rock samples for relative age dating. Additional core data will be necessary to correlate the quarry exposures and to extend correlations throughout the state.

Biostratigraphic Zonation of the Silurian in Central Illinois (Norby and Mikulic). A 4-inch diameter core of the complete Silurian section at the Lincoln Gas Storage Field in Logan County has been crushed for conodont extraction. The Ordovician-Silurian contact indicated by conodonts agrees with the lithologic description, but conodonts recovered from the upper part of the core shows that the Silurian-Devonian boundary is somewhat lower than that suggested by the lithology. Conondonts should provide good biostratigraphic correlation of this central Illinois core to many of the type sections in northeastern Illinois and to the outcrop areas in western Illinois.

Subsurface Geology

Knowledge of the subsurface--fundamental to many Survey research projects--is gained through acquisition, preservation, and study of borehole samples, cores, geophysical records, fossil samples, and drillers logs, and sometimes through scouting efforts. To make this valuable material available to the staff and to the public as quickly as possible, new emphasis is being placed on computerizing subsurface files and planning for improved storage efficiency and long-range expansion at the Survey Annex.

Geology of the Illinois Basin (Collinson, Sargent, and Atherton). Prepared at the request of the Geological Society of America, this summary article was recently revised and sent to reviewers. A major contribution is a revised Precambrian surface map that includes the newly discovered 20,000-foot Grayville Graben and new data on the Rough Creek and Mississippi Valley Grabens.

Lithofacies and Isopach Mapping of the Sauk Sequence in the Illinois Basin (Sargent). Lithofacies and isopach maps of the Sauk Sequence, the oldest Phanerozoic rocks in the Midcontinent, were compiled for the entire Illinois Basin. These maps show the development of rift systems that dramatically influenced early patterns of sedimentation and controlled the environments of deposition. Middle Cambrian shale of the Sauk Sequence occur in the deeper parts of the Rough Creek Graben and Reelfoot Rift.

Illinois Basin Ultradeep Drillhole (IBUD) (Eidel and others). In April 1986, more than 120 scientists took part in a workshop held in Urbana-Champaign to further develop plans for the proposed IBUD--one of 14 proposed drillholes selected for further study by the Scientific Advisory Committee of DOSECC (Deep Observation and Sampling of the Earth's Continental Crust, Inc.). Workshop participants from educational and scientific research institutions throughout the United States formed teams to design scientific experiments. Their efforts resulted in the creation of a 300-page plan and budget estimate that will undergo considerable revision. The final document will be submitted to NSF in about 6 months. At present, a proposal is being prepared to fund geophysical work for site selection.

If NSF funds the project, the 30,000-foot hole would be drilled in an area agreed upon by the working groups: a site near the Illinois-Kentucky border. From this hole, geologists hope to glean information on how rift-related intra-continental sags evolved, and more specifically, how crustal evolution led to the formation of the Illinois Basin.

The IBUD would have practical as well as theoretical benefits. It could yield valuable information about locations of oil and mineral deposits, such as fluorspar, coal, lead, zinc, thorium, beryllium, and rare earths. Because the drill site is in an area of active faults, a seismometer to measure earthquake activity could be placed in the borehole.

STRUCTURAL GEOLOGY

Ste. Genevieve Fault Zone, Missouri and Illinois (Nelson and Lumm). As part of the New Madrid Seismotectonic Study of the U.S. Nuclear Regulatory Commission, this study examined the structure and history of a major fault zone extending through Alexander, Union, and Jackson Counties, southwestern Illinois, and onward into Missouri. The fault zone underwent two important periods of movement. The first was in late Middle Devonian time, and the second, larger episode was in late Mississippian and Pennsylvanian time. Faulting took place by vertical movements, accompanied by sharp folding of sedimentary strata. Some geologists have suggested that the Ste. Genevieve Fault Zone is still active. No evidence was found for Quaternary movement, although reactivation of some fractures by modern stress appears possible.

Structural Geology of Southeastern Illinois (Nelson and Lumm). The June 17, 1985, issue of Oil and Gas Journal contained the paper, "Shawneetown Fault Zone, Southeast Illinois: Structure and Petroleum Possibilities." It summarizes the geologic history of the intensely faulted area of southeastern Illinois, and suggests likely areas to drill for oil and gas.

A manuscript on the same subject is being prepared as an ISGS Circular. Full-color geologic maps of the Rudement, Equality, and Shawneetown 7.5-minute quadrangls are in press and will accompany the Circular.

Structural Features of Illinois--An Encyclopedia (Nelson). Work on an encyclopedia of all structural geologic features in the state of Illinois has begun. This work is being patterned after Mary McCracken's 1971, Structural Features of Missouri, and will supplement ISGS Circular 519, which provided bibliographic data only. All named structures in the state will be presented alphabetically, with descriptive paragraphs, location, list of references, and illustrations where appropriate. This format is intended to facilitate future revision. The publication will include a statewide map at a scale of 1:500,000, and will have an introductory section outlining the structural history of the Illinois Basin. It is envisioned as a companion to ISGS Bulletin 95, Handbook of Illinois Stratigraphy.

Thrust Faults in Southern Illinois--Result of Contemporary Stress? (Nelson and Bauer). The report is an outgrowth of various structural investigations in the Illinois Basin during recent years, particularly the NRC-supported studies of the fault systems of southern Illinois and investigations in underground coal mines. The Geological Society of America will publish the paper, which provides evidence that small north-trending thrust faults, observed in coal mines of southern Illinois and vicinity, are being formed in the modern stress field. Slippage along such little faults may be the cause of the small to moderate earthquakes that take place in Illinois.

Tri-State Committee on Correlation in the Pennsylvanian System of the Illinois Basin (Jacobson and Trask). The committee represents a joint effort of the three State Surveys to simplify and standardize stratigraphic terminology of the Pennsylvanian System of rocks across the Illinois Basin. The Transactions of the Illinois State Academy of Science published the paper, "Unifying Nomenclature in the Pennsylvanian System of the Illinois Basin." In this paper seven stratigraphic names were recommended to replace 15 existing names for seven stratigraphic units. The committee also met for a field trip to examine the interval it is currently working on. Jacobson serves as chairman and Trask as secretary of the committee.

Correlation of Stratigraphic Units of North America (COSUNA) Chart (Jacobson and Trask). AAPG published the COSUNA chart for the Mid-western Basin and Arches Region; Jacobson and Trask contributed the Pennsylvanian portion of the columns in Illinois.

PALEONTOLOGY/PALYNOLOGY

Seven scientists, all with other major responsibilities, contribute to the programs:

- Russell A. Peppers (Coal Section) supervises the Palynological Laboratory, the only laboratory in the central United States that rountinely provides age determinations and correlations of Pennsylvanian strata (particularly coal-bearing strata). Most of the 90 coal beds in Illinois can be identified and correlated by palynological means.

- Rodney D. Norby (Stratigraphy and Surficial Geology Section) supervises the Conodont Laboratory and Acid Digestion Laboratory. Conodont studies furnish important evidence for correlating Paleozoic rocks. Recently, conodonts were used to provide geologic ages for important drill cores from deep in the Illinois Basin. Conodonts also provide thermal index values, a measure of temperatures to which the rocks have been subjected during the generation and preservation of hydrocarbons.

  Dr. Norby also curates the Geological Survey Paleontologic Collection, arranges for loans of materials, and prepares widely used catalogs.

- James W. Baxter (Head, Industrial Minerals Section) supervises the Foraminiferal Research Laboratory, which provides additional means of correlating late Paleozoic rocks; foraminifera are especially useful for studying carbonate environments.

- Dennis R. Kolata (Basin Analysis Task Force) specializes in the study of Ordovician echinoderms.

- Donald G. Mikulic (Industrial Minerals Section) studies early Paleozoic arthropods.

- Charles Collinson (Head, Stratigraphy and Surficial Geology Section) specializes in Devonian-Mississippian invertebrates and conodonts.

The Paleontological Repository

The Paleontological Repository receives, curates, and preserves, as a basic data set, the fossils and locality descriptions collected and studied by the staff as well as those studied by other scholars. Eighty-one formally catalogued and curated Survey collections, dozens of uncatalogued field collections and several reference collections of international significance are in the repository.

Dr. Kent previously had main responsbility of the repository from 1959 until the fall of 1985 when Dr. Norby was appointed Curator upon Dr. Kent's retirement.

Carl Bays--Gilbert Raasch Fossil Collection from Wisconsin (Norby). A collection of approximately 100 fossil specimens, belonging to the University of Wisconsin-Madison, were recently identified among our collections and were returned to the University of Wisconsin. These fossils, primarily trilobites, were collected by Carl Bays and Gilbert Raasch in the 1930s and apparently were studied by them during their employment at the Illinois State Geological Survey.

A much larger collection of several thousand fossil and rock specimens from the Cambrian of Wisconsin still remain in our collections. These specimens collected by Raasch also belong to the University of Wisconsin-Madison and some to the Milwaukee Public Museum. Those will be sorted out as time permits and returned.

The Worthen Collection of Conularid Specimens (Norby). Borrowed last year by Kent State University, this important collection of type and figured specimens was returned in February.

Micropaleontology

Skeletal Apparatuses of Conodont Organisms (Norby). The individual skeletal elements belonging to various Chesterian and Pennsylvanian conodont biostratigraphic index species have been related to the whole animal. Identification of any skeletal element now permits recognition of the whole species. The elements are found in various recurring patterns, providing an indication of their arrangement within the conodont animal. Several hypotheses of their function within the conodont animal have been analyzed and were discussed in a paper given in Nottingham, England, in July 1985. The paper will be published in a book in the summer of 1986.

Silurian Conodont Succession in Western Illinois (Norby, Sargent, and Mikulic). As part of the reorganization of Silurian biostratigraphic research a study of the Silurian conodont succession begun by Matthew Avcin early in the past decade has been revived. Some faunas are already in hand and many of the outcrops have been described. This study should provide precise correlation to a core in Logan County and to sections in northeastern Illinois that were reported in a 1985 Geological Society of America field trip guidebook. Understanding of stratigraphic wedge-outs in western Illinois is also an important goal of this study.

Mechanized Preconcentration of Conodonts from Acid Residues (Khan, Norby, and Baxter). Handpicking of conodonts from the host rock under a microscope is tiresome and time consuming. To accelerate and "mechanize" this separation process, different mineral processing methods were tried. Initial tests indicate that a preferential attachment of conodonts to waxy surfaces could be utilized to separate them from other minerals Tests are planned to optimize the separation using a laboratory-scale shaking table with wax-coated surface.

Macropaleontological Studies

Discovery of a Diverse Fauna of Goniatite Cephalopods in Lower Pennsylvanian (Devera). A find of goniatite ammonoids will help establish faunal affinities between the Caseyville Formation of southern Illinois and equivalent formations of neighboring states and of Europe. The restricted environment in which they were found has added paleobiological importance to this discovery. Aptychus appendages have been found closely associated with the goniatites. Charles Mason of Morehead State University, an authority on goniatites, has agreed to work with Devera and will co-author a paper on the ammonoids, for publication in the Journal of Paleontology in the near future.

Goniatite cephalopod.

Trace Fossils of the Lower Pennsylvanian (Devera). The goal of this project is to use trace fossils to distinguish marine from non-marine early Pennsylvanian sandstones in southern Illinois, in the area currently being mapped under the COGEOMAP program. The project would permit reconstruction of depositional environments and construction of paleogeographic maps.

Paleobiology of Mitrate and Cornute Carpoids--Echinodermata (Kolata). Carpoids are a very rare, enigmatic, extinct group of echinoderms known from Cambrian- to Pennsylvanian-age rocks throughout the world. Some of the best preserved specimens occur in Cambrian and Ordovician rocks of Illinois and adjacent states, and some of the finest material in the world is in the paleontological collections of the ISGS. Long-term studies are being conducted on the functional morphology, phylogeny, evolution, and systematics of the carpoids.

Upright Tree Stumps in the Roof of the Herrin Coal (DeMaris; and DiMichele Smithsonian Institution). Upright stumps and fallen trunks of Lepidodendron trees were found associated with the earliest facies of the Energy Shale in Freeman Coal Mining Company's Orient No. 6 Mine in Jefferson County. The trees were rooted in peat that became the Herrin Coal, and their fallen trunks became coalified compressions in the roof shale. The specific Lepidodendron species is uncommon in most swamp assemblages known from coal balls, suggesting that this last swamp stand was already affected by changing the water table and nutrient conditions that prevailed at the end of the coal-forming swamp.

Palynological Studies

Palynological Correlation of Major Pennsylvanian (Upper Carboniferous) Time Stratigraphic Boundaries in the Illinois Basin with those in Other Coal Basins of Euramerica (Peppers and Lowry). This study will provide a framework for comparing stratigraphic relationships of strata in the Illinois Basin and elsewhere. New information and reinterpretation of these correlations prevented completion of this project within the report period. Dr. Peppers is proposing that the Atokan-Desmoinesian boundary be raised from the top of the Murray Bluff Sandstone to the top of the Seville Limestone and that the Westphalian C-D boundary should be lowered slightly to that same position based on paleobotanical information.

Palynological Changes at the Desmoinesian-Missourian Boundary (Peppers). An abstract entitled "Palynological Changes at the Desmoinesian-Missouri (Pennsylvanian) Boundary and Some Possible Causes" was submitted for the 1986 annual meeting of the North-Central Section of the Geological Society of America in Kent, Ohio, in April 1986. The paper was the result of the more comprehensive project on the correlation of major time stratigraphic boundaries. This paper should be timely in light of increased interest in biotic extinctions, for example in relation to the younger Cretaceous-Tertiary boundary and the dinosaurs' demise, which has been recently attributed to one of the periodic impacts of extraterrestrial bodies on the earth's surface.

Although the timing of the Desmoinesian-Missourian boundary would coincide with one of these impact episodes, it is proposed that reduction in atmospheric carbon dioxide content and a temporary change to a semi-arid climate due to glaciation in the southern hemisphere were the triggering mechanisms that caused the significant palynological changes.

Identification and Correlation of Some Coals in Southern Illinois as Part of the COGEOMAP Program (Peppers and Lowry). Numerous samples of coal and shaly coal have been submitted for spore analysis by teams mapping the geology in several quadrangles in Pope and Johnson Counties (COGEOMAP program, see Geologic Mapping). As a result of palynological investigations, the Bell Coal was identified from several new localities. The area of the Reynoldsburg Coal was extended, and a coal equivalent to the Tarter Coal Member of northwestern Illinois was identified for the first time in southern Illinois. This study also confirms earlier conclusions that the Delwood Coal is in the lower Spoon Formation and not upper Abbott Formation, and that the type section of the Abbott Formation needs revision. A palynological study of coals in the Abbott and Spoon Formations, carried out about 12 years ago, has been valuable in providing information on the stratigraphic ranges and relative abundance of the spores.

Paleoecology of Pennsylvanian Coal-Swamp Floras (Peppers and Lowry). A program investigating the paleoecology of Pennsylvanian coal-swamp flora began about 15 years ago. It has been brought to a temporary conclusion with the publication of a summary paper in collaboration with T. L. Phillips, paleobotanist, University of Illinois, and W. A. DiMichele, Smithsonian Institution. The latter specializes in compression fossils, whereas T L. Phillips is an authority on coal-ball petrifaction (preservation of plants in limestone concretions within coal seams). Data from palynology (spores) has been integrated with other forms of plant preservation. This integrated approach in coal paleobotany has not been duplicated elsewhere.

The main focus has been the Illinois Basin, but the study of the development of Pennsylvanian floras has been extended to other coal basins in North America and Europe in order to obtain a better understanding of similarities and variations in deposition of peat. Interpretation on the environments of deposition, including climate and its influence on the distribution and quality of the coal deposits, was an important aspect of the study.

Other Palynologic Activities (Peppers and Lowry). Several samples from diamond-drilled cores from Franklin County were submitted by a coal company for spore analysis in order to determine whether the Herrin (No. 6) Coal split into two major benches or whether the Springfield (No. 5) Coal was present. The study showed that the Herrin Coal had split. Also in cooperative efforts with other states, counsel, advice and identifications were provided to the Missouri Geological Survey on spores from 10 cores and to the Arizona Geological Survey on several carbonaceous shale samples.

Several coal samples taken adjacent to the Desmoinesian-Missourian boundary in Oklahoma were analysed to confirm the position of the boundary. This study represents a continuing program in support of the Middle Pennsylvanian Working Group of the Subcommission of Carboniferous Stratigraphy.

Two outside manuscripts on palynology were also reviewed; and counsel and advice were provided to three graduate students (Illinois, Iowa, Louisiana), who are writing theses on palynology. Additionally, about 40 photomicrographs, a correlation chart for the Pennsylvanian and Upper Carboniferous and other data were provided to Alfred Traverse of Pennsylvania State University for inclusion in a textbook on palynology.

COMPUTER RESEARCH AND SERVICE

The Computer Research and Service Section (CRSS) was given a broader scope with the upgrading of the unit to a section and with the incorporation of the Geographic Information System (GIS) into the section's mission. Both E. D. McKay and R. J. Krumm transferred into the section, bringing knowledge and experience in the use of the GIS Dr. McKay is the new head of the section. The Lands Unsuitable for Mining Program (LUMP) also was transferred from the Environmental Studies and Assessment Unit to CRSS.

Geographic Information System Workshops, Seminars, and Presentations (McKay and Krumm). During the course of the year, workshops, seminars, and presentations on the use of the Illinois GIS were given for over 200 individuals from universities, other geological surveys, industry and the private sector. Delegations from Missouri Tennessee and Pennsylvania reviewed GIS technology at the Survey. The versatility and practicality of the Survey's GIS applications is continuing to attract the attention of industry, government, and the public.

Geographic Information System Applications (McKay, Krumm, Hines, and S. Miller). The GIS has been used to provide maps for many projects. A series of 12 maps was produced for an Environmental Inventory for the Illinois-Michigan Canal Project in northeastern Illinois. The maps displayed the geologic settings in the area as well as the location of other features such as natural areas, state parks and road networks. Many maps were plotted for the Environmental Atlas, which is part of the State of Illinois SSC proposal. One of these maps, the Prime Agricultural Soils Map, was included with a map set on the Satellite Image Map of Northeastern Illinois. Maps showing landforms were automated for 25 7.5-minute quadrangles along the Mississippi River in western Illinois as part of the Long Term Ecological Research Project. Base maps were prepared for the Geology for Planning Coal Mining Project in Perry County and for a siting project to locate groundwater resources for the Chrysler-Mitsubishi facility near Bloomington-Normal.

Use of the GIS to Model Earthquake Damage Potential (McKay). The Illinois Emergency Services and Disaster Agency requested geologic information that could be used to prepare a realistic earthquake preparedness drill in Richland County, Illinois. Using the statewide data bases on the GIS and making some assumptions about the behavior of surficial materials in the county during earthquakes, we produced a map series at 1:100,000-scale showing lowest, intermediate, and highest risk areas for earthquake damage. On the risk maps were plotted selected lifeline services, such as electric transmission lines and pipelines, to indicate where such features might be disrupted by an earthquake. The exercise demonstrated the utility of the GIS for production of risk maps, but widespread application of the analytic techniques must await further reserach on the seismic behavior of earth materials.

ILLIMAP Update (McKay, DuMontelle, and Scoggin). The ILLIMAP computer file of the Illinois Public Land Survey (PLS) grid is being edited to remove errors produced in the transfer of the file to the LUMP GIS. When complete this effort will allow production of accurate base maps showing the PLS. This file is also the basis for calculations of the coordinates used for plotting well locations and, therefore, its accuracy determines the accuracy of well coordinate calculations from legal descriptions. New USGS 7.5-minute quadrangle maps will be used to further improve the file when they become available. A portion of the ILLIMAP file was evaluated by the USGS National Mapping Division in Rolla, Missouri, and found to meet their standards of map accuracy.

Development of a Computer-Aided Data Management System for Map Orders (Schulte, Gaines, and McKay). To cut the costs of handling orders for the Satellite Image Map of Northeastern Illinois, the CRSS developed a computer-aided invoicing system. This system uses the ENR Prime 750 minicomputer and enables one temporary data entry operator to process orders for Satellite Image Maps. The SATMAP system consists of seven forms (input screens, printed reports, and mailing labels) and seventeen programs, all using the INFO database management software on the Prime. The system was developed and tested in less than two weeks and will serve as a model for further computer automation of repetitive and tedious jobs at the Survey.

Computer Automation of Well Data in the Geologic Records Unit (Denhart). The major accomplishment of the GRU this year is the automation of the monthly drilling report, which had previously been done manually by the Oil and Gas Section. This manual effort had required counting all permits issued each month in each county, all completed wells by type and county, and all new fields and pays discovered each month. The new system virtually eliminates manual handling of the records, which involve an average of about 600 permits per month.

In the continuing effort to assure the quality of automated well data, we printed and checked 133,000 well locations from the Basic Well Data File against the original well documents.

Data Processing for Research Affiliates and Other Agencies. Considerable data processing and programming efforts were expended during the year on projects for Dr. T. Phillips of the University of Illinois and for the Natural History Survey. These projects are cooperative efforts in which both parties benefit from the research effort.

Annual Waterflood and Oil Production Statistics (Gaines). The annual summary and analysis of waterflood and oil production data, one of the most significant support efforts of the Computer Research and Services Section, has been completed. This year the tabular output of the analysis was printed on a high quality printer at the Computer Services Office of the University of Illinois. This will substantially increase the quality of the published tables that comprise the annual report.

Reconfiguration of Remote Job Entry Capabilities (Schulte). Hardware and software necessary to maintain Remote Job Entry capabilities to the University of Illinois' computers were installed. Installation of this software and equipment allows continued use of the large mainframe computers at the university through computer hardware in the Natural Resources Building.

Data Processing Services (Computer Reseach Services staff). The following table lists the larger data processing services provided in support of research and operations at the Survey and for others.

	Computer System		
	ENR	UI	ISGS
Project	Prime 750	IBM	11/34
Waterflood data		X	
Oil production data		X	
Library data			X
Coal paleobotanical data		X	
Chemical data		X	
Financial Office data			X
Radiocarbon dating calculations		X	
Geophysical data		X	
Particle size data		X	
Coal data		X	X
Mine subsidence insurance claim data	X		
ILLIMAP revision	X		
GIS applications	X		
Satellite map orders	X		

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES

Mary E. McGuire, Dennis L. Reed, Jo Ann Munnis, and Dorothy H. Huffman (top) and Marilynn L. Farnham (bottom, center) process and fill orders for the Satellite Image Map of Illinois. The first press run of maps was sold out within days of the map's release on December 2, 1985. Another run of 10,000 was quickly ordered; to date, approximately 13,000 maps have been sold. No other map or publication of the ISGS has enjoyed such popularity.

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES

Support services include supplying library references and information; receiving and distributing incoming mail, commodities, and equipment; processing and shipping outgoing orders for publications, maps, and other materials; maintaining the telephone switchboard and information office; conducting public field trips, dealing with a variety of inquiries, distributing educational materials, and overseeing press relations; fabricating, maintaining, and repairing scientific, office, automotive, and other equipment and instruments; supervising the word processing system; providing editorial, graphics arts, typography and publications services, and planning and supervising new construction and building renovations.

PUBLICATIONS, GRAPHICS, AND PHOTOGRAPHY UNIT

Clear, accurate, and attractive scientific reports are the primary products of the Publications, Graphics, and Photography Unit. Other major publication projects include state maps, poster sessions (graphics plus text), and speech/slide presentations. The staff also prepares brochures, in-house forms, lists, and signs; edits abstracts, papers, speeches, proposals, ad copy, and special reports for affiliated agencies; and assists scientists at early stages in the preparation of data for written or graphic presentation.

1985 offered opportunities for innovation. During the last 11 months, the Publications, Graphics, and Photography Unit

- expanded graphics products and services. An author's vision of an entirely new publication--an environmental atlas--took form as an artist created the publication in mockup: covers, format, and illustrations. Funding was obtained as a result of the visual presentation. The objective was similar in other innovative art projects, which included a folio of high-tech jacket designs to help present a 10-part SSC proposal, a multi-color brochure layout depicting glacial history of a national heritage site, and a two-color design/format for a new public information brochure. High demand for poster exhibits continued to challenge all artists--demonstrating the power of full-color graphics to enhance scientific/technical ideas and data.

- initiated consultative analysis and structural editing. Authors submitting papers (destined for outside journals with editorial services) and contract reports with short deadlines were offered the option of manuscript analysis only--in contrast to the traditional analysis and polish. Expanding this technique, editors collaborated with authors to develop style, structure, and other guidelines for soliciting copy from authors.

- introduced product conceptualization and development. The editors demonstrated their own research, interview, and writing skills with the creation of a variety of public information brochures.

Changing needs and unexpected demands have challenged the skills and flexibility of our core staff of 2 editors, 3 graphics artists, photographer, typographer, and coordinator/editor. Expanding and contracting demands have required flexible staffing--a permanent core plus reliable free-lance talent. Flexible staffing has also resulted in economies of operation.

Principal Illinois State Geological Survey publications for the 11-month period of May 1985 through March 1986 include the following:

Circular Series: comprehensive reports and reference works representing completion of a major phase of geologic research, a critical development in stratigraphy, or other substantial and enduring compilation of data.

C 534 Landslide Inventory of Illinois. M. M. Killey, J. K. Hines, and P. B. DuMontelle. 28 p., 25 figs., 1 plate. (completed/ distributed)

C 535 Glaciation and Origin of the Geest in the Driftless Area of Northeastern Illinois. H. G. Willman, H. D. Glass, and J. C. Frye. 20 p., 13 figs. (in preparation)

C 536 Coal Resources of Grundy, La Salle, and Livingston Counties, Illinois. R. J. Jacobson. 58 p., 30 figs., 10 tables, 6 plates. (completed/ distributed)

C 537 K-Bentonites of the Ordovician Decorah Subgroup, Upper Mississippi Valley: Correlation by Chemical Fingerprinting. D. R. Kolata and J. K. Frost. 20 p., 19 figs., 6 tables. (in press)

C 538 Structural Geology of Southeastern Illinois and Vicinity. W. J. Nelson and D. K. Lumm. 70 p., 29 figs., 1 table. (in preparation)

C 539 Stratigraphic Correlations of the Seelyville, Dekoven, and Davis Coal Members--Spoon Formation (Illinois), Staunton Formation (Indiana), or Beds-Carbondale Formation (Western Kentucky). R. J. Jacobson. 70 p., 12 figs., 7 tables, 2 plates. (in preparation)

Illinois Mineral Series: reports of significant advances in basic and applied research in the area of mineral resources, or compilations of mineral economic data.

IMN 92 Removal of Sulfur from Illinois Coals via Charring and Partial Oxidation. R. R. Ruch, C. Chaven, and C. W. Kruse. 30 p., 8 figs., 8 tables. (completed/distributed)

IMN 93 Illinois Mineral Industry in 1981-83. I. E. Samson and S. B. Bhagwat. 38 p., 14 figs., 30 tables. (completed/distributed)

IMN 94 Coal Recovery from Mine Wastes of the Historic Longwall Mining District of North-Central Illinois. L. A. Khan, D. J. Berggren, and L. R. Camp. 19 p., 17 figs., 8 tables. (in press)

IMN 95 The Hornsby Area of Low-Sulfur Herrin (No. 6) Coal in Central Illinois. W. J. Nelson, with contributions by P. J. DeMaris. 50 p., 26 figs., 3 color plates. (in preparation)

Environmental Geology Series: reports of significant advances or pivotal discoveries in basic and applied environmental geological research.

EGN 111 Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Ilinois: Preliminary Geological Feasibility Report. J. P. Kempton, R. C. Vaiden, D. R. Kolata, P. B. DuMontelle, M. M. Killey, and R. A. Bauer. 63 p., 25 figs., 6 tables. (completed/ distributed)

EGN 112 A Stratigraphic Study of Beach Features on the Southwestern Shore of Lake Michigan: New Evidence of Holocene Lake Level Fluctuations. C. E. Larsen. 31 p., 11 figs., 2 tables. (completed/distributed)

EGN 113 Characterization of Volatile Sulfur Compounds Produced from Illinois Coal Chars. 14 p., 14 figs., 3 tables. (completed/ distributed)

EGN 114 Characteristics and Potential Uses of Historic Longwall Mining Sites in North-Central Illinois. S. C. Bradford, D. J. Berggren, and P. B. DuMontelle. 50 p., 22 figs. 8 plates. (in preparation)

EGN 115 Design Principles for a Coal Desulfurization Process with Iron Sulfides as In Situ Catalysts. (R. H. Shiley, R. E. Hughes, K. L. Konopka, C. C. Hinckley G. V. Smith, T. Nishizawa, N. Yoshida, M. Saporoschenko), 15 p., 5 figs., 6 tables. (in preparation)

EGN 116 Inorganic Composition and Sedimentation Rates of Backwater Lakes Associated with the Illinois River. R. A. Cahill and J. D. Steele. 40 p., 12 figs. (in preparation)

EGN 117 Assistance to Six Small Water-Short Communities in Illinois Electrical Resistivity Surveys. V. L. Poole. 41 p., 14 figs. (in preparation).

Illinois Petroleum Series: reports of essential data on fuels exploration and research.

IP 127 Petroleum Industry in Illinois, 1984. J. Van Den Berg, J. D. Treworgy, and J. R. Elyn. 146 p., 2 figs., 15 tables. (completed)

Contract/Grant Reports: timely reports of research generated in response to specific geologic and environmental issues.

1985-1 Geophysical Studies at the Sheffield Low-Level Radioactive Waste Disposal Facility to Evaluate Potential Pathways for the Escape of Contaminants. P. C. Heigold and T. H. Larson. 23 p., 16 figs. (completed/distributed)

1985-2 Size and Maceral Association of Sulfide Grains in Illinois Coals and Their Washed Products. R. D. Harvey and P. J. DeMaris. 49 p., 13 figs., 6 tables. (completed/distributed)

1985-3 Ste. Genevieve Fault Zone, Missouri and Illinois. W. J. Nelson and D. K. Lumm, with contributions by H. R. Schwalb. 94 p., 32 figs., 1 table. (completed/distributed)

1985-4 Chemical Composition and Geochemistry of the New Albany Shale Group (Devonian-Mississippian) in Illinois. J. K. Frost, D. L. Zierath, and N. F. Shimp. 134 p., 16 figs., 22 tables. (completed/distributed)

1985-5 Information System on Chemistry of Illinois Coal. R. D. Harvey, Aravinda Kar, M. H. Bargh, and L. B. Kohlenberger. 20 p., 7 figs., 6 tables. (completed/distributed)

Cooperative Groundwater Reports: results of research conducted jointly by the State Geological and Water Surveys.

Coop 10 Geology, Hydrology, and Water Quality of the Cambrian and Ordovician Systems in Illinois. A. P. Visocky, M. G. Sherrill, and Keros Cartwright. 136 p., 45 figs., 6 tables. (completed/ distributed)

Educational Extension Materials: guidebooks, brochures, and exhibits designed specifically to inform and educate the public.

1985A A Guide to the Geology of the Salem Area. D. L. Reinertsen. 9 p.

1985B A Guide to the Geology of the Elizabeth Area. D. L. Reinertsen. 6 p.

1985C Pekin Geological Science Field Trip. D. L. Reinertsen, R. S. Nelson, and M. M. Killey. 13 p.

1985D Lawrenceville Geological Science Field Trip. D. L. Reinertsen. 8 p.

Educational Resources Booklet. D. L. Reinertsen.

1985-86 Geological Science Field Trips brochure.

Reprints of Papers Published in Journals:

1985-G Definition of Contaminant Pathways: An Integrated Geophysical and Geological Study. R. H. Gilkeson, T. H. Larson, and P. C. Heigold.

1985-H New Albany Shale Group (Devonian-Mississippian) Source Rocks and Hydrocarbon Generation in the Illinois Basin. M. H. Barrows and R. M. Cluff.

1985-I Stratigraphic and Interregional Changes in Pennsylvanian Coal-Swamp Vegetation: Environmental Inferences. T. L. Phillips, R. A. Peppers, and W. A. DiMichele.

1985-J Maceral Distributions in Illinois Coals and Their Paleonvironmental Implications. R. D. Harvey and J. W. Dillon.

1985-K Unifying Nomenclature in the Pennsylvanian System of the Illinois Basin. R. J. Jacobson, C. B. Trask, C. H. Ault, D. D. Carr, H. H. Gray, W. A. Hasenmueller, D. Williams, and A. D. Williamson.

1985-L Relationship Between Geochemistry of Coal and the Nature of Strata Overlying the Herrin Coal in the Illinois Basin, USA. C.-L. Chou.

1986-A Vogelgnathus, a New Mississippian Conodont Genus. R. D. Norby and C. B. Rexroad.

1986-B A Gravitational Slide in the Energy Shale Member Overlying the Herrin (No. 6) Coal Member in Southern Illinois. W. J. Nelson and C. T. Ledvina.

1986-C Facies, Formation Boundaries, and Chronostratigraphy in the Upper Part of the New Albany Shale Group (Devonian-Mississippian) in the Illinois Basin. M. L. Reinbold.

1986-D Depositional Environments of Strata of Late Desmoinesian Age Overlying the Herrin (No. 6) Coal in Southwestern Illinois and the Occurrence of Low-Sulfur Coal. J. E. Palmer, C. B. Trask, and R. J. Jacobson.

1986-E Paleoenvironments and Distribution of Low-Sulfur Coal in Illinois. C. G. Treworgy and R. J. Jacobson.

1986-F Timing and Development of Mineralized Veins During Diagenesis in Coal Beds. J. C. Cobb.

1986-G Tonsteins in the Coalfields of Western Europe and North America. K. Burger and H. H. Damberger.

1986-I Shawneetown Fault Zone, Southeast Illinois: Structure and Petroleum Possibilities. D. K. Lumm and W. J. Nelson.

Other Publications and Reports:

Illinois State Geological Survey Publications: Catalog. 176 p.

3 Geologic Maps: 7.5-minute maps of the Rudement Quadrangle (Saline County), the Equality Quadrangle (Gallatin and Saline Counties), and the Shawneetown Quadrangle (Gallatin County).

2 Public Information Brochures on the programs and staff of the ISGS.

Illinois Mine Subsidence Research brochure.

Oil and Gas Monthly Drilling Reports. May 1985 through March 1986.

Completed Publications Projects (May 1985 - March 1986)	1983-84	1984-85	1985-86
Circulars	1	4	2
Illinois Mineral series	2	2	2
Environmental Geology series	2	6	3
Illinois Petroleum series	1	1	1
Contract/Grant Reports	5	3	5
Field Trip Guidebooks	3	2	4
Guidebooks	0	3	0
Cooperative Groundwater Reports	1	0	1
IL Scientific Survey Joint Report	-	1	0
Reprints	12	11	14
Abstracts	29	35	11
Papers	13	37	25
Oil and Gas Drilling Reports	12	12	11
Poster Exhibits	8	7	15
Large Plates	15	16	3
Brochures	1	3	4
Special reports, proposals, and others (including Pubs Catalog)	-	16	36
TOTALS	104	158	137

Graphics and Typesetting	1984-85	1985-86
Drafting (no. of items)		
Slide copy: maps, graphs, charts, diagrams, etc.	364	224
ISGS publications and posters: maps, graphs, cross sections, etc. Also miscellaneous items.	902	947
Large plates	16	3
Covers for publications	29	31
Typesetting (no. of pages)		
Slide copy	233	127
Text, tables, forms, charts, etc.	1,797	1,690

Reproductions

The Publications, Graphics, and Photography Unit duplicates materials for publications, talks, and exhibits, using an Ozalid blue-line processor as well as various photographic techniques. Services are estimated.

Photography	1984-85	1985-86
Photos taken for staff		1,283
2 x 2 inch slides: color/blue foil	2,791	3,724
duplicates	891	1,991
PMT prints developed for staff	5,211	4,622
Prints made	2,702	3,987
Portraits taken	14	27
Color prints made	18	52
Mylars made	123	180
Black/white film developed for staff	39 rolls	82 rolls
Color film developed for staff	142 rolls	161 rolls
Screened PMTs for staff		437

Ozalid

Division by Groups and Sections	1984-85	1985-86
Information & Technical Services:		
Oil and Gas Development	4,268	3,206
IL Coal Mines	1,156	815
Other	494	217
TOTAL	5,918	4,238

	1984-85		1985-86	
	Mylar	Paper	Mylar	Paper
Mineral Resources	93	257	11	205
General & Environ. Geology	98	184	36	208
Chemical & Mineral Engr.	--	--	--	--
Administrative Services	40	62	2	150
Other	--	--	--	--
TOTAL	231	503	49	563

INFORMATION AND TECHNICAL SERVICES UNIT

Information Office

Many people write, visit or telephone the Survey seeking maps, publications and answers to questions. To meet the needs of the public, the Survey maintains an Information Office where questions are answered and maps and publications are sold.

During February 1986, more than 300 people purchased maps and publications from this office; this sample suggests that more than 3,600 customers will be served by the end of the year. The Information Office also handled about 250 mail orders and 120 telephone orders during February. Also during February, the Switchboard received approximately 2,943 incoming calls, projecting a yearly toal of about 35,316 calls.

Mail Room

The Mail Room is the central distribution center for all publications and maps of the Geological Survey. Stocks of all in-print publications and maps are maintained to fill mail orders and distribute to Survey staff as needed. The Mail Room also maintains a stock room for all office supplies required by the staff.

Maps and publications distributed during the reporting period:

ISGS publications	28,258
ISGS maps	17,230

(This figure includes the distribution of satellite image maps.)

USGS maps	17,029
ISGS blue-line maps	5,502

Individual orders filled, excluding satellite image map orders: 5,649. Mail orders for 9,171 statewide satellite image maps were not handled directly through the Mail Room.

Postage meter:

Individual pieces run through meter	70,153
Amount of postage used	$29,747.80

During January, Mail Room space was reorganized. Also, the Mail Room moved many of the 7.5-minute topographic maps to a more consolidated location. This move freed an area where large flat maps and other publications may be stored.

The Survey is preparing to receive 45 1:100,000-scale, 30 by 60 inch planimetric and topographic maps from the U.S. Geological Survey.

Duplicating Services

Duplicating Services took delivery of a new Baumfolder 714 folding machine in early March of this year. This heavy-duty high volume machine replaces the small table-top unit. The new machine will allow us to fold larger sheets of various paper weights with less wastage. Duplicating Services received a new paper plate punch in October. The punching of the paper plates lets the operator be more consistent in the placement of plates on the duplicator.

During this reporting period, 3,513,492 printing impressions were made.

Well Log Copy Service

The Survey copies well log records requested by customers in person, by mail, or by telephone. During the last reporting period, the Survey produced 14,455 logs; 78,807 single data sheets; 185 logs for wells greater than 6,000 feet deep; and 927 parts of logs. In the second year of service, there has been an increase in each category from the previous year:

Logs - 41 percent
Single Data Sheets - 76 percent
Wells deeper than 6,000 feet - 85 percent
Parts of logs - 43 percent

During January, the Well Log Copy Service moved to a different office. The new area has a window and an air conditioner, creating a better working environment.

Statewide Satellite Image Maps

The Survey released the Statewide Satellite Image Map on Monday, December 2, 1985.

Due to its high popularity, 1,900 copies were sold over the counter during the first week. Counter sales then had to be discontinued in order to retain copies for the mounting mail orders.

An estimated 800 calls per day on eight incoming lines were handled through December. About 600 calls per day were handled through January into February. Almost 80 percent of these calls required conversation with the caller regarding information of the satellite map; correct address, cost of maps, shipping charges, office hours and general map information. Numerous phone and counter inquiries regarding the map are still being received.

Counter sales resumed on January 2, 1986 and continued through February 5, 1986.

The Duplicating Services area was transformed into a map processing center. Here, the tubes were filled with maps, sealed, labeled, and prepared for shipping.

Two temporary persons were hired for about a two month period. These people assisted with the massive amounts of mail; sorted mail; prepared mailing labels, invoices, ledger sheets, as well as assisted in the packaging, labeling and shipping of the maps. Many of the Survey's own staff assisted as their time allowed.

During December the Survey received mail orders requesting 7,657 maps; during January there were requests for 1,365 maps; and during February there were requests for 149 maps.

Map sales ceased on February 5, 1986 when our supply became almost exhausted.

WORD PROCESSING CENTER/TECHNICAL RECORDS UNIT

The Word Processing Center and Technical Records Unit were merged during the Fall of 1985. Technical Record's supervisor, Carol Fiock, retired during September 1985; Mrs. Fiock was not replaced. In order to continue functioning with less staff the following changes have been or are being implemented:

- Copies of outgoing correspondence are filed alphabetically instead of numerically.

- Only incoming mail not addressed to staff is opened.

- All incoming mail is routed through a series of mailboxes by group, section, and unit. This has allowed the assistant in Educational Extension several extra hours per week to answer questions from the public instead of spending time hand-carrying mail to individuals.

- Using guidelines from the State of Illinois Records Center, files are being culled to determine the propriety of retaining certain records.

- At the conclusion of alphabetizing the files, a determination will be made on decentralization of all files with the exception of the official files from the office of the Chief.

Word Processing

In addition to implementing a number of changes in the Technical Records Operation, Word Processing staff have continued to provide expert advice to individual word processing operators throughout the system. Also, the word processing station in this office provides an expert operator to key into the system any work overload from various parts of the organization.

Based on a one-month sample, the following mail count is projected for this reporting period: 103,764 pieces of mail handled, 2,256 mail returned for central filing, and 6,528 items received for the library. Unprecedented sales of the State Satellite Image Map heavily impacted ongoing operations in this unit during the period of peak orders. Staff responded with an outstanding effort, which resulted in minimal complaints from customers.

TECHNICAL DESIGN, OPERATIONS, AND MAINTENANCE UNIT

The Technical Design, Operations, and Maintenance Shop provides a variety of special support services that would otherwise be contracted through outside vendors or the University of Illinois. These services include ongoing building maintenance services, repair and maintenance to scientific, office, and automotive equipment; and the fabrication of specialized items requested by scientists and others.

A representative description of support services performed is as follows:

General Shop

- Constructed an exciter system assembly for an Intrinsic Germanium Detector at a savings of $1,000.

- Gathered materials and fabricated 15 locking steel pipe well protectors. The outside vendor estimate for completion of this project was $3,780. Our shop completed the job for $315.

In the machine shop, Dave Cooley and Chris Wilson install a cooling fan in a sound-deadening cover obtained from Springfield surplus.

Chris Wilson constructs a stand with a sound-deadening cover for a computer printer.

In the metal shop, Phil Williams sands a table, preparing it for painting. Item was picked up from surplus in Springfield.

- Fabricated a special inside tube for a soil-sampling apparatus used at the Sheffield research site.

- Fabricated an electromagnet for use in experiments to remove the sulfur from coal.

- Fabricated several mail distribution boxes required to implement the new mail/information distribution system.

- Completed modifications to the building and movable equipment as required by Illinois Department of Labor inspectors applying OSHA standards.

- Located space and constructed a cage to store compressed gas cylinders.

- Cleaned, repaired, and painted the Giddings Drill Rig; replaced wheel bearings and tires on the trailer for the OMI Research Boat.

- Provided advice and assistance to management with regard to building space realignment and the division of space. Provided manpower and expertise in constructing "temporary" walls to house additional staff. New space configurations resulted in 20 additional office cubicles during the reporting period. Removed and renovated laboratory space, hoods, islands, and other apparatus as required.

- Assisted management in pinpointing offices and work areas to be painted by the University of Illinois. This resulted in 13 offices being painted--a process that must be continued in the future.

- Assisted management in presenting a variety of plans for the construction of the Shop and Equipment Building; maintained "eyeball" contact with contractors as construction continued to help ensure that standards set out in the CDB specifications were met.

- Continued the program of assessing and picking up used equipment in Springfield in order to fulfill some needs of the scientists and staff in the building. Renovated this "excess" equipment in order to make it usable by Survey staff.

During the reporting period, 315 jobs were completed involving internal work orders. In addition, numerous jobs were finished due to verbal requests, notes, and the completion of ongoing maintenance procedures.

Electronics Shop

The Electronics Shop provides support in electronic installation, maintenance, and repair throughout the Survey. In addition, electrical work is accomplished within acceptable University guidelines. Services were provided to each Group as follows:

Joseph S. Kaczanowski troubleshoots a computer telephone modem in the electronics shop.

Group	Work Orders
Mineral Resources	27
General and Environmental Geology	51
Chemistry and Minerals Engineering	55
Administrative Services	22

Some equipment serviced during this reporting period includes neutron activation equipment, mass spectrometer, earth resistivity meters, computer data switch, Altair microprocessor, downhole logging equipment, seismograph apparatus. printers/video terminals, Ozalid blue-line machine.

Some jobs completed:

- Installation of cable and connectors necessary for all new video terminals and printers connected to the Digital Equipment or Prime Computer.

- Revamping the wiring for 11 word processor stations and printers with the Word Processing Center was moved.

- Installation of twisted pair cable for the NBI Word Processor to IBM-PC Network.

Garage/Automotive

During this reporting period, two vehicles were replaced: a van and a carryall. In addition, the SSC contract purchased a vehicle. Two replacement vehicles have been requisitioned and should be added to the fleet during April 1986.

In order to keep the Gasoline Pumping Operation operational, a reconditioned pump was purchased and installed during the fall of 1985.

In August 1986, at a celebration for both new and retiring ISGS staff, Chief Leighton expressed appreciation for Ernest Adair's many years of fine service.

Personnel

Ernest Adair underwent hip surgery on May 1, 1985, and retired August 31, 1985. November 19, 1985, Oscar Richter was hired to fill the vacancy created by Mr. Adair's retirement.

LIBRARY/MAP ROOM

The Library/Map Room continued to provide a wide range of services to Survey staff. Journals, bibliographies, and other materials were routed to notify staff of new work being done in their fields. The librarians consulted with researchers on their specific information needs; verified and completed citations; prepared bibliographies on requested topics; conducted on-line literature searches; located articles, reports, and books, borrowed materials on interlibrary loan; and instructed staff in the use of the Library/Map Room and its resources. The Map Room also provided space for 64 meetings.

This year showed a dramatic increase in the use of library services. Reference questions increased more than 100 percent and interlibrary loans increased substantially. Fifteen staff members attended hands-on library workshops in the use of the University of Illinois Library's on-line catalog. The librarians also considered the question of how to better meet all Survey staff needs regarding journal availability and distribution. Experimentation with the journal routing system was undertaken. A current periodicals area and a weekly "journals received" list have been established and further modifications are being planned.

The state, "M", and reference sections were shelf read and shifted to make room for an estimated 4 years growth at current rates. Room 472 was reorganized to provide two study areas, a work space for the SSC project archivist, and improved work space for Petroleum Information's microfilming project. A shelflist of state documents was started and is more than 50 percent complete. Twelve boxes of gift materials were received and processed. The Library cataloging backlog was cut in half. Catalog card production continued at a tremendous rate and Map Room card production was automated.

Library Operating Statistics

	1986-85	1985-84	1984-83
Acquisitions: Total	1,862	2,543	4,164
Books	71	100	75
State documents	442	591	548
U.S. documents	533	424	647
Canada documents	94	135	128
Miscellaneous documents	314	401	234
Manuscripts	43	22	4
Maps	359*	868*	623
Field notebooks	6	2	7
Photographs	--	--	1,898
Total items withdrawn	256	**	1,006
Serials titles and newsletters received	260	246	290
Library Circulation: Total	2,987	3,063	3,615
Books, documents, serials, misc.	2,239	1,820	2,218
Maps	748	1,087	1,193
Field notebooks	49	45	48
Photographs and slides	30	111	156
Visitors	413	569	361
Interlibrary Loans: Total	812	658	415
from University of Illinois	579	522	323
from Lincoln Trail Library System	233	136	92
Reference questions	1,060	515	271
On-line literature searches	54	48	70
Periodicals routed (not counted in circulation statistics)	1,736	2,343	2,344

* Reflects materials processed into the Map Room collection.
** 20 journal titles that had been discontinued for 5 or more years were approved and withdrawn.

HUMAN RESOURCE OFFICE

On November 1, 1985, the Personnel Office with responsibilities of recruitment and placement, was transferred to the Administrative Services Group. On January 1, 1986, the Personnel Office was renamed the Human Resource Office with responsibilities expanded to staff performance evaluation and appraisal, compensation based on performance, training and development, affirmative action/equal employment opportunity, establishment of communications for counseling, and improvement of the quality of work life and productivity. At the same time the staff was expanded and the office moved into a 2-room suite.

Activity Measures Table

Information Responses	
Inquiries from staff/public	480
Calls received	3,600
Calls placed	2,520
Personnel Reports/Memos	
DENR	31
Workforce analysis (12)	
Affirmative action (13)	
Absenteeism reports (6)	
University of Illinois	138
Activity Effort Plan (96)	
Monitored Workload Plans (42)	
Chief/Staff	42
Personnel Activities	
Applications received	740
Letters received regarding employment	1,500
Acknowledgment letters written	2,000
Ads placed in professional journals & local papers	37
Announcements posted	189
Candidates interviewed	121
New staff appointments processed	9
Resignations	5
Retirements	6
Terminations	0
Medical leaves	1
Contract Personnel Transactions	284
New (68)	
Transfers (81)	
Extensions (114)	
Terminations (21)	

Requests for approval to hire	13
Requests prepared for exception to hiring freeze	14
Requests for reclassification of code personnel	7
Requests for temporary help	29
U of I Steno Services (8)	
DENR (21)	
Salary Progression Charts prepared/updated	209
Workshop training courses/seminars attended	9
Meetings attended	135
Conducted audits of staff attendance records	3
Requests for U of I Tuition and Fee Waiver	38
Summer 1985 (9)	
Fall 1985 (17)	
Spring 1985 (12)	
Requests for Allied Agency ID Cards	132

CAPITAL DEVELOPMENT BOARD SHOP AND EQUIPMENT BUILDING PROJECT

A multipurpose building under construction on Griffith Drive, northeast of the Natural Resources Studies Annex (south of St. Mary's Road in Champaign), will provide an additional 3,360 square feet of much-needed space for the Geological Survey. Construction of the pre-engineered wood frame and metal building began in mid-December; target completion date is early April.

The new building will contain

- Technical Design, Operations, and Maintenance Shop, which will include a work bench, drill presses, welding equipment, a bench vise, and other small tools and equipment.

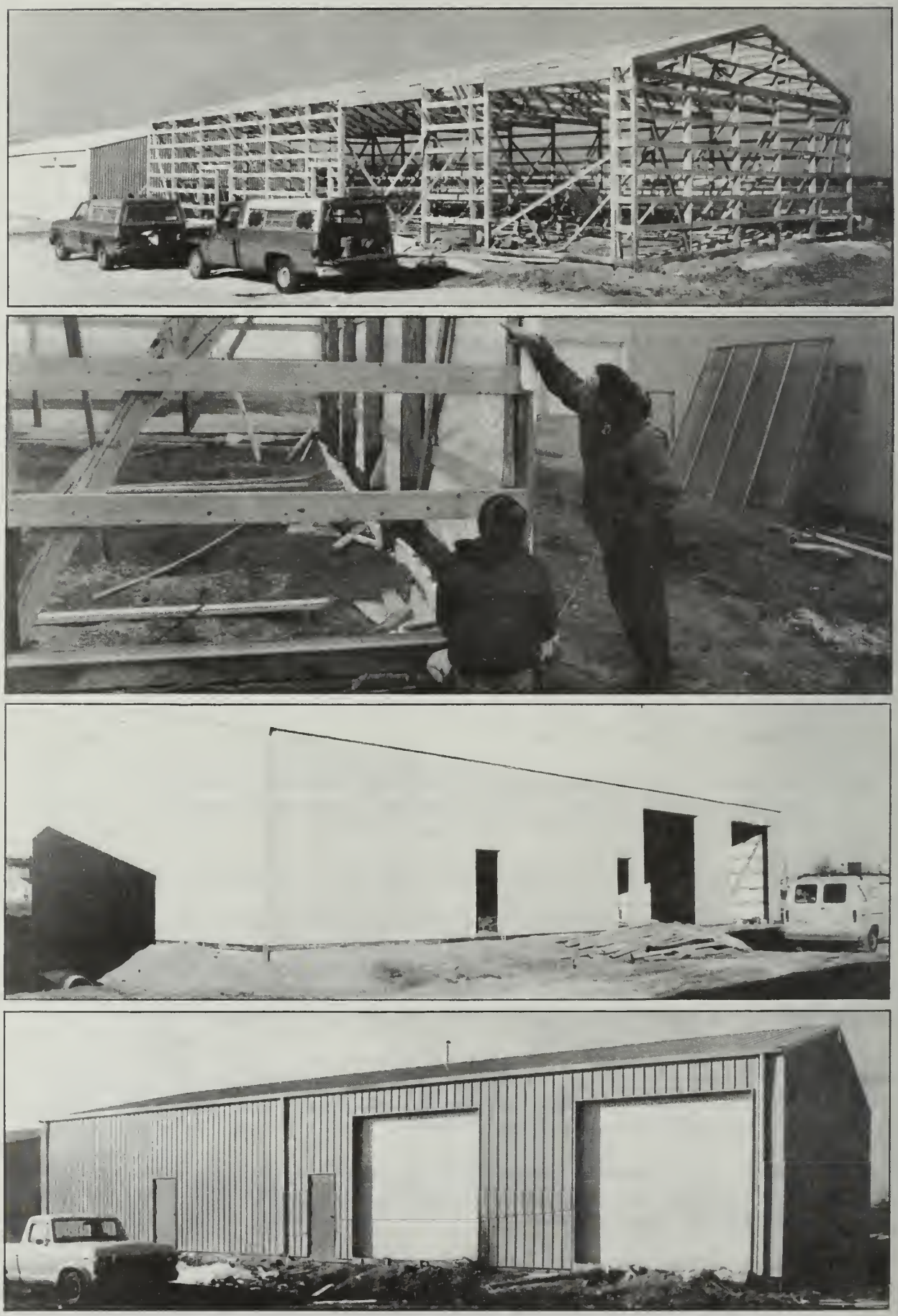
- Reproduction services shop, where ISGS publications are produced.

- Three separate storage rooms for equipment used by the Earth Hazards/Engineering Geology, Stratigraphy and Surficial Geology, and Groundwater Sections (such as drilling and testing equipment, outboard motors and sampling and monitoring equipment used in lake and river studies, and pumps and stakes for groundwater investigations).

- Heated area (30 by 12 feet) to be used for repairing, steam cleaning, and maintaining large vehicles and equipment that currently must be worked on outdoors.

- Storage area (approximately 40 by 12 feet) for large equipment such as drill rigs and the Lake Michigan studies power boat that now sit outdoors all year around.

A deck above the ceiling will be used for miscellaneous storage (the building is 14 feet high, and the ceiling over part of the building is only 8 feet high, providing extra storage room). Additional drains have been stubbed in the floor so that a laboratory might be housed in the building at some future date.



Stages in the construction of the multipurpose shop and equipment building northeast of the Natural Resources Studies Annex. The new building will provide an additional 3,360 square feet of much-needed space for the ISGS.

EDUCATIONAL EXTENSION AND PUBLIC RELATIONS UNIT

The Educational Extension and Public Relations Unit provides information and materials on the state's geology, mineral resources, and landscape to elementary, high school, and college science teachers as well as to interested laymen and students. The staff also presents slide-illustrated talks concerning research and service at the Geological Survey to teacher workshops, high school science classes and clubs, and citizen groups throughout the state.

Geological Science Field Trips (Reinertsen et al.). These field trips, although open to the general public, are designed for teachers so as to furnish them with background material for classroom use. A guide leaflet is distributed to the participants. Additional guide leaflets from about 85 previously held field trips are maintained on permanent file so that teachers and others may obtain them for later use. During this report period, about 43 of these older guide leaflets were distributed each month.

Attendance for the geological science field trips held during this report period totaled approximately 346 compared with 459 for the 1984-1985 report period. Individual field trip attendance figures were as follows: Salem, 20 April, 69; Elizabeth, 18 May, 130; Pekin, 12 October, 82; and Lawrenceville, 9 November, 65.

Distribution of Information (Carlisle and Reinertsen). More than 440 mail inquiries from the general public were received to be answered either with a letter or with publications. About half of these requests were from schools, other educational groups, and libraries. More than 200 long distance telephone inquiries were answered, many by sending publications. More than 100 individuals came to the unit office seeking information and materials. Distribution of the Educational Series booklets totaled approximately 235 copies. About 20 topographic map sets made from out-of-date topographic maps were distributed to Illinois schools during this report period; the "Guide to the Use of Illinois Topographic Maps" accompanied the sets. More than 100 additional copies of this guide were furnished to teachers. More than 170 copies of the "Landforms of Illinois" map by James A. Bier (Department of Geography, University of Illinois) were distributed this past year. More than 15,400 copies of the Satellite Image Map of Illinois (scale 1:500,000) have been sent out since 3 December 1985.

Rock and Mineral Sets (Zelinsky, Klitzing, McKinney, and Carlisle). The free set of 35 labeled rocks, minerals, and fossils distributed to Illinois schools, scout councils, and other educational groups is designed primarily for classroom display purposes and for aid in identifying unknowns brought in by students. The sets are distributed at the rate of one per school or one per 500 in enrollment. Zelinsky, Superintendent of the Geological Samples Library, supervises the assembling of the materials under the guidance of the Educational Extension and Public Relations Unit. During this report period, approximately 138 rock and mineral sets plus 18 orders for replacement specimens were distributed

to Illinois institutions. In addition, some 50 coal-ball slices were sent to Illinois schools.

Educational Resources (Reinertsen). The Survey mailed an abbreviated revised list of services offered to Illinois schools and teachers to each school in the state and to the regional superintendents. The bulk mailing totaled more than 6,970. The list which is also distributed at teachers' meetings, includes nontechnical Survey publications, maps, and services suitable for elementary and secondary school use.

Educational Exhibits (Reinertsen). Educational exhibits on the geology of the state and the research and service activities of the Survey were displayed as follows for the past year: Illinois Oil and Gas Association annual meeting (Robinson, June 20); and the Illinois Science Teachers Association annual meeting (Normal, October 4-5). In addition, representative educational materials were assembled for display during the visits of personnel from the Illinois Legislative offices and the Department of Energy and Natural Resources. Assistance was also furnished to other sections and groups in the Survey with their respective displays for these visits and for outside exhibits.

Lectures (Reinertsen and Carlisle). Presentations were made to the following groups: Coal workshops for teachers at Quincy, Harper College-Northeast at Prospect Heights, Rend Lake Community College, Ina, and Lincolnland Community College, Springfield; Earth Science teachers workshops by Western Illinois University at Rock Island, Macomb, and Springfield; Pana Rotary Club; St. John Lutheran School, Champaign; St. Matthew Catholic School, Champaign; Joliet retired state employees group; Double I Gem and Mineral Society, Danville; and the Worthen Rock and Mineral Club, Carthage (Carlisle).

Press Relations (Staff). Five press releases concerning field trips, a new staff member, and a promotion were sent either to the Illinois Information Service, Springfield, or to the University of Illinois News Bureau. Four interviews were held with radio and newspaper people regarding field trips and the Satellite Image Map of Illinois.

Other Activities (Reinertsen). Two manuscript were reviewed: one was for the North Cook County Soil and Water Conservation District and the other for the Earth Science Club of Northern Illinois. Assistance was given to a graduate student from Eastern Illinois University; he was seeking help with a stratigraphic problem encountered along the Embarras River at Lake Charleston. Also, a German geologist and his wife were conducted on a geological tour in the La Salle-Wedron area for a day.

Reinertsen represents the Director of the DENR on the Statewide Advisory Board of Conservation Education for the Illinois State Board of Education. For part of the year, he was editor for Earthshine, the Illinois Earth Science Association newsletter. He also serves on the Liaison Committee for the IESA.

RECOGNITION AND SERVICE

August 1986 Survey celebration: Howard R. Schwalb, retiring member of the Oil and Gas Section, listens to his biography presented by Jonathan H. Goodwin, Assistant to the Chief.

Richard D. Harvey, Coal Section, accepts a 25-year certificate and congratulations from Chief Leighton for his excellent contributions in research and service at the ISGS.

RECOGNITION AND SERVICE

HONORS AND AWARDS

Karen A. Albrecht was elected to full membership in Sigma Xi, the scientific honorary society, in February 1986.

James C. Bradbury, Principal Geologist Emeritus was honored as a Distinguished Member of the Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Class of 1984-85, "In recognition of and appreciation for his outstanding service to the mining industry, and to the Society."

Keros Cartwright has been elected to the Advisory Council of the U.S. Committee of the International Association of Hydrogeologists. This Council will organize the hydrogeology program of the 28th International Geological Congress scheduled for 1988 in Washington, D.C.

Charles Collinson has been nominated for a special award for service to the Society of Economic Paleontologists and Mineralogists. The award will be made in Atlanta in June 1986.

Donald R. Dickerson was cited by Neil F. Hartigan, Attorney General for the State of Illinois, for his outstanding work on analyses of wood and soil samples for traces of petroleum products and his testimony which helped to convict a murderer in Marshall, Illinois.

David L. Gross received an award for "Outstanding Volunteer Service" from the United Way of Champaign County.

Russell J. Jacobson received an M.S. degree in geology from the University of Illinois.

Vickie L. Poole completed her Master of Science degree at Purdue University in May 1985. She was also elected to full membership in Sigma Xi.

William R. Roy completed his Ph.D. in soil chemistry at the University of Illinois in October 1985.

Janis D. Treworgy received a Ph.D. degree in geology from the University of Illinois.

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Albrecht, K. A., and J. C. Parker. 1985. Sample volume effects on hydraulic and solute transport parameters. Agronomy Abstracts, American Society of Agronomy.

Aldridge, R. J., M. P. Smith, R. D. Norby, D.E.G. Briggs, and E.N.K. Clarkson. 1985. The structure and function of Carboniferous polygnathacean conodont apparatuses (Abs.). In R. J. Aldridge, R. L. Austin and M. P. Smith [eds.], Fourth European Conodont Symposium (ECOS IV), Abstracts, Southampton, p. 1-2.

Barton, L. L. G. V. Johnson, and S. M. Orbock Miller. 1985. The Effect of Azospirillum brasilense on iron absorption and translocation by sorghum. Journal of Plant Nutrition.

Bauer, R. A., B. B., Curry, R. C. Vaiden, A. M. Graese, W. G. Dixon, and Wen-June Su. 1985. Engineering Characteristics of Bedrock for the Proposed Superconducting Super Collider in Illinois. Geological Society of America Abstracts with Programs, vol. 17, no. 7, p. 520.

Bhagwat, S. B.. 1985. Kohle im Illinois Becken--ein energiepolitisches Dilemma. Paper published in West German mining magazine "Glueckauf."

Bhowmik, N. G., J. Adams, R. Anderson, M. Demissie, D. Gross, J. King, L. Lubinski, R. Sparks, and W. Wendland. 1985. Long Term Ecological Research on Illinois Rivers. Illinois Academy of Science, v. 78, no. 3 and 4, p. 247-261.

Bhowmik, N. G., J. R. Adams, R. V. Anderson, R. A. Cahill et al. 1985. Long-term ecological research on Illinois rivers. Transactions of the Illinois Academy of Science, vol. 78, 247-261.

Bhowmik, N. G., D. L. Gross, and P. G. Risser. 1985. A Conceptual Model of Erosion and Sedimentation Processes. World Congress on Water Resources, Brussels, Paper 58a, p. 199-208, Illniois State Water Survey Reprint 681.

Bonnell, L. M., and T. F. Anderson. 1985. Sulfur isotopic analyses of disseminated pyrite in Cretaceous black and green mudstones. Abstracts with Programs, 1985 Annual Meeting, vol. 17, no. 7, p. 528.

Bonnell, L. M., and T. F. Anderson. Sulfur isotopic analysis of disseminated and macroscopic pyrite: Hole 603B. In P. A. Meyers, D. Dunn, et al., [eds.], Initial Reports of the Deep Sea Drilling Project, vol. 93, U.S. Government Printing Office (in press).

Bradford, S. C., P. B. DuMontelle, R. A. Bauer, and R. D. Evans. Determining causes of damage to structures in Illinois with assistance of relational data-base management system. Bulletin of the Association of Engineering Geologists, vol. 23, no. 3 (in Press).

Brigham, W., and C. G. Treworgy. 1985. Geographic Information System puts Illinois the Map. Design Graphics World, June, p. 16-18.

Brower, R. D., A. P. Visocky, I. G. Krapac, G. R. Peyton, B. R. Hensel, and J. S. Nealon. Evaluation of hazardous liquid waste disposal by deep well injection in Illinois. Proceedings of the 2nd Annual Canadian American Conferences on Hydrogeology, Banff, Alberta (in press).

Cahill, R. A.. 1985. Illinois large rivers, handbook of field and laboratory techniques. Illinois Large Rivers Long Term Ecological Research Program Series No. 3, 109 p.

Cahill, R. A., and A. D. Autrey. 1986. Measurement of 210-Pb, 137-Cs, organic carbon and trace elements in sediments of the Illinois and Mississippi Rivers. Journal of Radioanalytical and Nuclear Chemistry (in press).

Cahill, R. A., and J. D. Steele. 1986. Cesium-137 as a tracer of recent sedimentary processes in southern Lake Michigan. Hydrobiologia (in press).

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SCIENTIFIC AND EDUCATIONAL CONTRIBUTIONS

Professional Societies

Robert A. Bauer serves as Chairman of the Rock Mechanics Committee for the North-Central Section of the Association of Engineering Geologists.

James W. Baxter is Vice-Chairman of the American Mississippian Stratigraphy Research Group of the Society of Economic Paleontologists and Mineralogists for 1985-86. He is also a member of the Mining Engineering Committee of the Society of Mining Engineers of AIME of the ad hoc subcommittee to study ways of improving mining engineering in 1986.

Subhash B. Bhagwat is Chairman of the Economics Committee of the Center for Research on Sulfur in Coal for 1986.

James C. Bradbury was appointed Chairman, Scholarship Committee, and a member of the Executive Committee, Industrial Minerals Division of the Society of Mining Engineers-AIME.

Susan Carol Bradford serves as co-editor of the newsletter of the North-Central Section of the Association of Engineering Geologists and is on the Public Information Committee for the Association of Engineering Geologists.

Ross D. Brower serves as historian for the Midwest Groundwater Conference.

Larry R. Camp is secretary for the Physical Coal Cleaning Task Group for the Center for Research on Sulfur in Coal.

Keros Cartwright serves as Associate Editor of the Journal of Hydrology and as Co-Chairman of the Committee on Hydrostratigraphic Units, Geological Society of America. He is Chairman of the Subcommittee on Geotechnics of Waste Disposal for ASTM and serves on ASTM's Committee on Waste Disposal.

Heinz H. Damberger is Secretary-Treasurer of the Illinois Mining Institute and is Program Chairman for their two-day technical programs. He is also a member of the Rock Mechanics Award Committee of the Coal Division of AIME-SME, a member of the Nominating Committee of the Geological Society of America Coal Division, and a member of the Editorial Board of the International Journal for Coal Geology.

Donald R. Dickerson is co-Chairman of the Science Talent Search Committee of the Illinois State Academy of Science, a delegate of the ISAS to the Illinois Junior Academy of Science, and Chairman of the local committee for paper sessions at the IJAS State Fair. He is also a member of the Nominating Committee for Sigma Xi.

Paul B. DuMontelle served on the National Short Papers Committee for the Association of Engineering Geologists and on the screening committee for the Illinois-Indiana Section of the American Institute of Professional Geologists. In addition, he is legislative chairman for the Illinois-Indiana Section of AIPG and Vice Chairman of the North Central Section of AEG.

Henry P. Ehrlinger III is Chairman of the Technical Committee of the Industrial Minerals Division of the Society of Mining Engineers of AIME, and Chairman Elect of their Program Committee. He is also a member of the Mining Engineering Committee of SME/AIME.

J. James Eidel serves as Vice President of the Society of Economic Geologists and is a member of SEG's Executive Committee. He is also Chairman of SEG;s Program Policy Committee and of the Funding Priority Review Committee. He is a member of the Steering Group for the Continental Interior Crustal Studies Consortium, and attended their meetings in Denver and St. Louis. In addition, he co-chaired the Red Mountain Task Force meeting of the Panel on Mineral Resources of the Continental Scientific Drilling Committee in July 1985 in Tucson, AZ. He also attended the annual meetings of the Geological Society of America in Orlando, FL in October 1985 and of the AIME in New Orleans in March 1986.

Leon R. Follmer serves on the International Editorial Advisory Board for the Journal of Ouaternary Science published in Londn, UK. He is a member of the Soil Science Society of America Committee on Soil-Geomorphology, a newsletter editor of the Illinois Soil Classifiers Association.

Robert H. Gilkeson serves as Review Editor for the journal Ground Water Monitoring Review.

Jonathan H. Goodwin served for the tenth consecutive year as secretary of the Yellowstone-Bighorn Research Association.

Mark Grubb serves as Co-Chair of the Geomorphology Seminar at the University of Illinois.

Richard D. Harvey serves as Secretary of a subcommittee of the ASTM Committee on Coal and Coke and as a member of the Nominating Committee of the Society for Organic Petrology.

Bruce Hensel serves as Co-Editor of the Illinois Groundwater Association Newsletter.

Beverly L. Herzog serves as a member of the editorial board of the journal Ground Water. She has also had two book reviews published, one in Water Resources Bulletin and one in Water International.

Richard H. Howard is a member of the Potential Gas Committee, the Interstate Oil Compact Commission Enhanced Recovery Committee, and the Geological Committee of the Illinois Oil and Gas Association.

Randall E. Hughes is chairman of the Publicity Committee and a member of the Publication Committee of the Clay Mineral Society.

Russell J. Jacobson is newsletter editor for the Illinois-Indiana Section of the American Institute of Professional Geologists. He is also Chair of the Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin.

Myrna M. Killey participated in an earth science field trip for teachers and students at the GSA meeting in Orlando, Florida in November, and was commended for her efforts by the GSA Ad Hoc Committee on Minorities in the Geosciences.

Dennis R. Kolata is a member of the Ordovician System Correlation Committee of the International Union of Geological Sciences and is Chair of the Nominating Committee, Division of Sedimentary Geology of the Geological Society of America.

Carl W. Kruse is a member of the organizing committee for the First International Conference on Processing and Utilization of High Sulfur Coals and Chairman for the session on New Applications for High Sulfur Coals.

Morris W. Leighton serves as Secretary-Treasurer of the Society for the Illinois Scientific Surveys. He convened the organizational meeting of the Association for Research on Sulfur in Coal, and is a member of the Board for that organization. He also served as Chairman, Ad Hoc Committee on Low Level Radioactive Waste for the Association of American State Geologists.

John M. Masters is a member of SME-AIME's Book Publishing Committee.

Edward Mehnert serves as co-editor of the Illinois Groundwater Association's newsletter.

W. John Nelson gave a talk on the Shawneetown Fault Zone to the Illinois Geological Society.

Rodney D. Norby was appointed 1986 Program Chairman by the International Pander Society.

Donald F. Oltz serves on the Committee on Statistics in Drilling and the Membership Committee of the American Association of Petroleum Geologists. He is also on the Enhanced Oil Recovery Committee of the Interstate Oil Compact Commission.

Russel A. Peppers is a member of the Middle Pennsylvanian Working Group of the Subcommission of Carboniferous Stratigraphy of the International Geologic Union. He also serves on the Midcontinent Pennsylvanian Stratigraphic Working Group of the Society of Economic Paleontologists and Mineralogists.

Philip C. Reed serves as co-chairman, Geology Divison, Illinois Junior Academy of Science. He also is on the Editorial Board of the research journal Ground Water.

David L. Reinertsen serves on the Education Committee of the Illinois Earth Science Association and as editor of the Illinois Earth Science Association newsletter.

James B. Risatti was Chairman of the Microbial Coal Desulfurization Task Force at the Center for Research on Sulfur in Coal and Chairs the Working Group, Bottom Suspension Zone, Ocean Drilling Project Black Shale Committee (Joint U.S./West German Colloquium). He is an invited member of the Precambrian Paleobiology Research Group - Archean, sponsored by the National Science Foundation, Center for Evolution and Origin of Life (UCLA), NASA, and the National Geographic Society.

William R. Roy serves as Research Coordinator of the Waste Management Task Group for the Center for Research on Sulfur in Coal.

Beverly J. Seyler is AAPG delegate for Illinois and is Vice President and President of the Illinois Geological Society.

Neil F. Shimp serves as Vice Chairman of Committee D-5 on Coal and Coke of ASTM and is a member of that committee's Executive Committee. He is also on the Secretariat of the International Standards Organization (solid fuels) Task Group 14 on Trace Elements in Coal. In addition, he is a contributing editor to the Journal of Coal Quality.

Michael D. Stephenson is a member of the Fuels and Chemicals from Coal, and Related Desulfurization Studies Task Groups of the Center for Resarch on Sulfur in Coal.

Christopher J. Stohr serves as Secretary of the Illinois Mapping Advisory Council. He is also First Deputy Chairman of the Engineering Applications Committee of the American Society of Photogrammetry and Remote Sensing and served as Session Chairman of the Fall Joint Meeting of the Western Great Lakes Region, ASPRS.

C. Brian Trask is Secretary of the Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin.

Conferences and Field Trips

Karen A. Albrecht presented a paper co-authored by J. C. Parker on "Sample Volume Effects on Hydraulic and Solute Transport Parameters" to the annual American Society of Agronomy meetings in Chicago in December 1985.

Ann D. Autrey attended the national meetings of the American Chemical Society in Chicago in September 1985.

Robert A. Bauer attended the 26th U.S. Symposium on Rock Mechanics in Rapid City, SD in June 1985, and the 2nd Conference on Ground Control Problems in the Illinois Coal Basin at Carbondale, IL in May 1985.

James W. Baxter presented a paper co-authored by L. A. Khan on "Evaluating the feasibility of secondary recovery of Coals from Mine Wastes" to the 1985 Symposium on Surface Mining, Hydrology, Sedimentation and Reclamation in December 1985, in Lexington, KY. He also attended the meetings of the American Association of Petroleum Geologists/Society of Economic Paleontologists and Mineralogists in New Orleans, LA in March 1985, and the Society of Mining Engineers of the American Institute of Petroleum and Mining Engineers in March 1986 in New Orleans. In addition, he attended the U.S. Geological Survey McKelvey Forum in Denver. He also attended the SEG field trip on Mineral Resources of Central Arkansas.

Richard C. Berg presented a paper on the state stack-unit map to a regional meeting of the American Society of Photogrammetry and Remote Sensing and the American Congress on Surveying and Mapping.

Richard C. Berg and John P. Kempton were organizers of the 1985 Friends of the Pleistocene Field Conference. He also was co-leader of a field trip for a regional AEG meeting in De Kalb, IL.

Subhash B. Bhagwat attended the meetings of the Illinois Mining Institute in October 1985.

Susan Carol Bradford attended the meetings of the Illinois-Indiana Section of the American Institute of Professional Geologists in Vincennes, IN and the North-central Section meeting of the Geological Society of America in De Kalb in April 1985. She also attended the Geological Society of America's annual meeting in Orlando, FL in October 1985 and the North-central Section meeting of the Association of Engineering Geologists in Chicago in February 1986.

Richard A. Cahill gave a paper at the International Symposium on Nuclear Analytical Chemistry held at Halifax, Nova Scotia in June 1985.

Larry R. Camp attended the meetings of the Illinois Mining Institute and an Acid Rain Conference and a regional American Chemical Society meeting at Southern Illinois University at Carbondale.

Keros Cartwright was the keynote speaker at the 8th Annual Symposium on Geotechnical and Geohydrological Aspects of Waste Management, Ft. Collins, CO in February 1986; and was invited speaker at the annual meeting of the American Society of Civil Engineers, Denver, CO in May 1985. He was also invited to be Discussion Group Leader at the 16th Biannual California Water Conference in San Diego in September 1985. He served as a panel member of experts at the International Symposium on Alternative Low-Level Waste Technologies in Chicago, February 27 - March 1, 1986.

Chusak Chaven attended the annual meetings of the American Society for Testing and Materials in Louisville, KY, in August 1985.

Chen-Lin Chou was invited by Academia Sinica (Chinese Academy of Sciences) to visit China during September 1985. He lectured at the Institute of Geochemistry in Guiyang, Northwestern Institute of Soil and Water Conservation at Yangling, the Institute of High Energy Physics and Institute of Atomic Energy in Beijing, and Zhongshan University in Guangzhou.

Sheng-Fu Joseph Chou attended the 1985 annual meetings of the American Society of Agronomy and the Soil Science Society of America.

Barbara A. Cline presented a paper entitled "Solvent effects on the orientation of bonded phases on chemically modified graphite electrodes" to the central regional meeting of the American Chemical Society in Akron, OH, in June 1985.

Charles Collinson and N. P. Holm provided background material for planning the annual ENR conference which featured Lake Michigan as its topic and assisted the ENR staff in Springfield in scheduling speakers and assembling the agenda for the conference as well as providing a large part of the illustrative materials--both slides and poster photos.

B. Brandon Curry attended a working conference, "Pleistocene Geology and Evolution of the Upper Mississippi Valley," Winona, MN, and the Geological Society of America meeting in Orlando, FL. He also presented a paper co-authored by H. D. Glass on "Quaternary Glacial Stratigraphy of the Fox River Valley, Kane County, Illinois" to the North-Central Section, Geological Society of America in April 1985 at De Kalb, IL.

Heinz H. Damberger attended the Coal Quality Symposium in Reston, VA and the GSA North-Central meetings in De Kalb, IL in April 1985, the 2nd Conference on Ground Control Problems in the Illinois Coal Basin at Carbondale, IL in May 1985, and the meetings of the Illinois Mining Institute in Springfield, IL in October 1985.

Stephen K. Danner attended the 2nd Conference on Ground Control Problems in the Illinois Coal Basin at Carbondale, IL in May 1985, and the meetings of the Illinois Mining Institute in Springfield, IL in October 1985.

Ilham Demir presented a paper entiled "Distribution and Leachability of Na, Cl, and K in Coal" at the Geological Society of America annual meeting in Orlando, FL in October 1985.

William G. Dixon, Jr. attended a meeting of the Illinois-Indiana Section of the American Institute of Professional Geologist, eight meetings of the North Central Section of the Association of Engineering Geologists, and the North Central Section meeting of the Geological Society of America.

Paul B. DuMontelle presented a paper entitled "Illinois Mine Subsidence Research Program: Coal and Crops Working Together," co-authored by Robert A. Bauer, to the Conference on Ground Control at Carbondale and to the Illinois Mining Institute in Springfield.

Henry P. Ehrlinger III presented a paper entitled "Fine Coal Cleaning by the ISGS Aggregate Flotation Process," co-authored by R. R. Ruch, J. M. Buckentin, D. M. Rapp, and L. R. Camp at the annual meeting of the American Institute of Chemical Engineers' annual meeting in Chicago in November 1985. He and J. A. FitzPatrick also presented a paper on a similar subject, co-authored by J. B. Buckentin, R. D. Harvey, J. D. Steele, and R. R. Ruch at the Engineering Foundation Conferences on the Science of Technology of Processing Fine Coal in New Hampshire in August 1985. In addition he attended annual meetings of the Society of Mining Engineers of AIME in Albuquerque, NM in October 1985, the Illinois Mining Institute in October 1985, and the AIME in New Orleans in March 1986.

Leon R. Follmer led a field trip to the type section of the Malden Till Member for the Illinois Soil Classifier Association, and assisted in leading field trips for three U of I classes to study soils and geology. He also presented a paper entitled "The Evolution of Pedologic and Geologic Profile Concepts in the Midcontinent, U.S.A." at the American Society of Agronomy meetings in Chicago.

Joyce K. Frost attended the International Symposium on Nuclear Analytical Chemistry held at Halifax, Nova Scotia in June 1985, and the Geological Society of America annual meetings in Orlando, FL in October 1985.

John M. Fox attended the meetings of the North Central Section of the Geological Society ofAmerica in De Kalb, IL in April 1985, and the Midwest Friends of the Pleistocene conference and field trip in Rockford, IL in June 1985.

Edward M. Gefell attended the 2nd Conference on Ground Control problems in the Illinois Coal Basin at Southern Illinois University-Carbondale in June 1985, and a meeting of the North Central Section of the Association of Engineering Geologists in February 1986.

Robert A. Griffin presented papers entitled "Mechanisms of Contaminant Migration Through a Clay Barrier--Case Study, Wilsonville, Illinois", co-authored by B. L. Herzog, T. M. Johnson, W. J. Morse, R. E. Hughes, S.F.J. Chou, and L. R. Follmer, at the 11th Annual U.S. EPA Research Symposium in Cincinnati, OH in April 1985; "Batch-Type, 24-hr Distribution Ratio for Contaminant Adsorption by Soil Materials" co-authored by Sack, Roy, Ainsworth, and Krapac, to the ASTM Symposium on Environmental Test Method Development in Colorado Springs, CO in May 1985; "Geochemistry and Adsorption Processes" at the Geotechnical Engineering for Waste Disposal Projects, Austin, TX in October 1985; "Development of the 24-hr Batch Adsorption Procedure Emergency Standard" at the ASTM Meeting, D-34 on Waste Disposal, Bal Harbour, FL in November 1985; and "Feasibility of Land Disposal of Organic Solvents: Preliminary Assessment" at the Illinois Pollution Control Board Hearing, Champaign, IL in November 1985.

David L. Gross presented a paper and participated in field trips of the IV International Symposium in Paleolimnology in Austria in September; participated in the INQUA field trip to study tills in central and northern Finland sponsored by the Geological Survey of Finland; participated in an Environmental Law Short Course in Denver in preparation for work on the SSC; he participated in numerous state and national SSC activities including a site meeting at the Texas Accelerator Center and the CERN Accelerator School course in "Geodesy for large Accelerators" in Geneva, Switzerland.

Mark Grubb attended the 3rd International Fluvial Conference at Fort Collins, CO, and the Conference on Geology, Geomorphology, and Evolution of the Upper Missisisppi River Valley held at Winona, WI.

Keith C. Hackley attended the First International Conference on Processing and Utilization of High Sulfur Coals in Columbus, OH, and the Geological Society of America annual meetings in Orlando, FL in October 1985.

Ardith K. Hansel was field trip leader for the 1985 North Central G.S.A. at De Kalb and the 1985 Tri-State Field Conference at Chicago, contributing to the Tri-State guidebook. She also presented a paper at the International Quaternary Association Till Symposium and Field Workshop in Finland in August and participated in a Field Trip in Estonia in September. Dr. Hansel also presented a paper to the Multidisciplinary Geomorphology Seminar at the University of Illinois, Champaign-Urbana in October. She also was leader of informal field conferences for Indiana geologists in northern Illinois and Iowa geologists in eastern and northern Iowa.

Paul C. Heigold attended the spring meeting of the American Geophysical Union in Baltimore, MD in May 1985; a meeting on "Deep Crustal Studies in the Great Lakes Region" at Madison, WI in November 1985; and a meeting of the North Central Section of the Association of Engineering Geologists in Chicago, IL in February 1986.

Bruce Hensel attended meetings of the Illinois Groundwater Association in April and October 1985; North-Central Section of the Geological Society of America in De Kalb, IL in April 1985; Disposal of Drilling Waste Conference in Norman, OK in May 1985; the National Water Well Association's Canadian/American Conference on Hydrogeology held in Banff, Canada in June 1985, and the Governor's Conference on Lake Michigan in Chicago in September 1985.

Beverly L. Herzog attended the Ohio River Baisn meeting on Groundwater Policy Issues held in Louisville, KY in February 1986 and two Illinois Groundwater Association meetings.

Randall E. Hughes presented a paper co-authored by H. D. Glass entitled "Use of clay mineral composition for stratigraphic analysis" at the 34th Annual Denver Conference on Applications of X-Ray Analysis" in August 1985 at Snowmass, CO. He also gave a paper, "Origin of clay minerals associated with Pennsylvanian strata in the Illinois Basin," co-authored by P. J. DeMaris, W. A. White, and D. K. Cowin, at the 8th International Clay Conference in August 1985 at Denver, CO.

John P. Kempton was co-leader for the Friends of the Pleistocene Annual Meeting; R. Vaiden and B. Curry participated. He was also co-leader for the Friends of the Pleistocene Field Conference held in May 1985 at Rockford, IL.

Myrna M. Killey presented a paper co-authored by Paul B. DuMontelle entitled "Illinois Landslide Inventory: A Tool for Geologists and Engineers" to the Highway Geology Symposium national meeting in Louisville, KY in May 1985 and to the FHWA Region 5 Geotechnical Engineers Conference in Peoria in October, 1985. She also presented a paper co-authored by H. D. Glass on "The Wadsworth-Yorkville Till Member Boundary in the Southern Sector of the Joliet Sublobe, Northeastern Illinois" at the North Central Section of the Geological Society of America meetings in De Kalb, IL in April 1985. In addition, Susanne Orbock Miller and Myrna M. Killey attended the Geomorphology Symposium on Hillslope Processes held in September 1985 at SUNY-Buffalo, NY.

Timothy H. Larson attended the annual meeting of the Society of Exploration Geophysics in Washington, DC in October 1985.

Chao-Li Liu attended the 12th International Radiocarbon Conference in Trondheim, Norway in June 1985 and the First International Conference on Utilization and Processing of High Sulfur Coal in Columbus, OH in October 1985.

Morris W. Leighton presented a paper on "The Evolving Role of State Geological Surveys" at the North-Central Geological Society of America Meeting, De Kalb, April 25, 1985 and a condensed version of the paper at a Conference on Geosciences in the University in the 1990's, Louisiana State University, Baton Rouge, Louisiana, on May 13, 1985, and at a Forum on Geological Manpower, Ohio State University, Columbus, Ohio, October 11, 1985. He also served as moderator of the discussion on "Subsurface Mapping in the East-Geophysics, Geochemistry-Core Studies" at the USGS Cluster Meeting held at Myrtle Beach on February 26, 1985.

Donald K. Lumm attended the annual meetings of the Geological Society of America North-Central Section and the Illinois Mining Institute. He also attended three meetings of the Illinois Geological Society.

John M. Masters wrote a geology guide for a field trip conducted as part of the 1985 annual Aggregate Seminar, for the Illinois Department of Transportation, sponsored by their Bureau of Materials and Physical Research.

E. Donald McKay III has given tours, demonstrations, and discussions on the Prime computer's Geographic Information System for over 75 visitors representing over 20 different organizations. He gave invited papers on the Geographic Informatin System to the Association of American State Geologists, Mystic CT and to the Illinois-Indiana Section of the American Institute of Professional Geologists in Danville, IL. He also lectured to the Soil Geomorphology Seminar at the University of Illinois on loess along the Mississippi Valley.

Dennis P. McKenna presented a paper entitled "Age of the Surficial Tills in Boone and Winnebago Counties, Illinois: A Soil-Geomorphic Analysis: at the North-Central Section meetings of the Geological Society of America. He also served as co-leader of the 1985 Friends of the Pleistocene field conference and as co-leader of a field trip for the regional AAG meeting in De Kalb, IL.

Edward Mehnert attended meetings of the Illinois Groundwater Association; the North-Central Section of the Geological Society of America in De Kalb, IL; the Geochemical Modeling Workshop in Washington, DC; and the International Symposium on Subsurface Injection of Liquid Wastes in New Orleans, LA.

Jerry R. Miller attended the Conference on Fluvial Sedimentology in Ft. Collins, CO; the Generators Conference on Low-Level Radioactive Wastes in Chicago; and the International Symposium on Alternative Low-level Technologies in Chicago.

Michael V. Miller presented a paper co-authored by R. K. Stahlhut entitled "An automated soil/sediment database management system" at the annual meeting of the Soil Science Society ofAmerica held in Chicago in December 1985. He also attended the Friends of the Pleistocene Field Conference in Rockford in May 1985; the Pleistocene Geology and Evolution of the Upper Mississippi River Valley held in Winona, MN in August 1985; and a conference on non-point pollution of surface streams in Springfield, IL in February 1986.

Suzanne Orbock Miller attended the International Fluvial Sedimentology Conference in August 1985 at Ft. Collins, CO.

Rodney D. Norby participated in the Fourth European Conodont Symposium held at the University of Nottingham, England. The meeting held in late July 1985 included four days of technical sessions and ten days of field trips to study classic Paleozoic rock exposures. Dr. Norby coauthored a paper with the symposium organizer on the paleobiology of conodonts entitled "The Structure and Function of Carboniferous Polygnathacean Conodont Apparatuses." A second paper generated at the meeting entitled "Contact microradiography of conodont assemblages" will be published in the book Conodonts, Investigative Techniques, and Applications.

Some of the benefits from the meeting included new information on conodont biostratigraphy, international correlation of rock units and improved techniques for processing rock samples for conodonts. The opportunity to visit, examine and collect conodont reference samples from type Silurian sections and British reference sections of parts of the Ordovician and Lower Carboniferous strata will greatly aid in international correlation of Illinois rock units.

Rodney D. Norby presented a talk entitled "Lake Michigan shoreline erosion potential and sediment transport at high lake levels" on June 26, 1985, at Lake Michigan Shoreline Stabilization Seminar held at Zion, Illinois. This seminar, sponsored by the Illinois Department of Conservation, informed participants of projected precipitation and increases in lake levels, increased erosion at higher lake levels, and methods to stabilize beaches or to reduce the amount of erosion.

Donald F. Oltz attended the meetings of the Illinois Geological Society, the American Association of Petroleum Geologists, and the Interstate Oil Compact Commission in New Orleans, as well as a Geochemistry Symposium in Norman, OK.

Vickie L. Poole attended a meeting on Supercomputers in Hydrology--Future Directions held in West Lafayette, IN in September 1985, and an Illinois Groundwater Association meeting in Joliet, IL in October 1985.

Kristi Redding attended the regional American Chemical Society meetings at Carbondale, IL in November 1985.

J. Bruno Risatti presented "Bottom Suspension Zones: Recommendations for Research" to the Ocean Drilling Project Black Shale Committee, University of Hamburg, West Germany in May 1985. He was also an invited seminar speaker at the Instituto Microbiologica Agrarica, University of Pisa Pisa, Italy in September 1985; he presented a talk entitled "Microbial geochemistry of deep-sea methane and of sedimentary biogenic methane." He also attended the European Association of Organic Geochemists meeting in West Germany in September 1985, and the annual meetings of the Geochemistry Society in Orlando, FL.

Massoud Rostam-Abadi presented two papers at the North American Thermal Analysis Society Conference in San Francisco, CA in September 1985. One, co authored by D. Kwan and C. Chaven, is entitled "Interfacing and operation of a Dupont TGA with an IBM Personal Computer." The other, with R. W. Mickelson, is entitled "Serendipity and kinetic analysis." Both are published in the proceedings of the conference.

Richard H. Shiley attended the Acid Rain Conference at Southern Illinois University-Carbondale in April 1985; the Illinois Coal Development Board meeting, Urbana, IL in August 1985; the Second Annual Pittsburgh Coal Conference, Pittsburgh, PA in September 1985; the First International Conference on Processing and Utilization of High Sulfur Coals, Columbus, OH in October 1985; and the regional American Chemical Society Meeting at Southern Illinois University-Carbondale in November 1985.

Faith Stanke attended meetings of the Illinois Quaternary Association in Springfield in September 1985 and the Association of Iowa Archeologists in July 1985. She also presented a summary of her research on the Vermilion River project at a Geology Department Seminar at the University of Illinois.

Michael D. Stephenson presented a talk entitled "An Overview of Coal Desulfurization Research at the Illinois State Geological Survey" at Lawrence Livermore National Laboratory, Livermore, CA in August 1985. He also presented a talk co-authored by Carl Kruse on "An Economic Evaluation of Coal Pyrolysis with Char Hydrodesulfurization", and a second talk co-authored by M. Rostam-Abadi, L. A. Johnson, and C. W. Kruse on a Review of Gas Phase Desulfurization of Char" at the First International Conference on Processing and Utilization of High Sulfur Coals held in Columbus, OH in 1985. He also attended the Acid Rain Control Conference at Southern Illinois University-Carbondale in April 1985; the national meetings of the American Chemical Society in Chicago in September 1985.

Christopher J. Stohr presented a talk on "Current Applications of Remote Sensing by the Illinois State Geological Survey" to the Western Great Lakes Region meeting of the American Society of Photogrammetry and Remote Sensing; and a talk on "Engineering Geology Investigations of a Hazardous-Waste Disposal Site in West Central Illinois" to the annual meetings of the Association of Engineering Geologists in Winston-Salem, NC. He also attended the Fall Technical Conference of the ASPRS in Indianapolis, IN.

Wen-June Su attended the International Workshop on Dam and Reservoir Failure at Purdue University; the annual meeting of the Association of Engineering Geologists at Winston-Salem, NC; and several monthly meetings of the North Central Section of the Association of Engineering Geologists. He also attended a workshop on Seaman's Nuclear Moisture and Density Instrument.

C. Brian Trask attended the Midyear Meeting of the Society of Economic Paleontologists and Mineralogists at Golden, CO, and the North-Central Section meetings of the Geological Society of America at De Kalb, IL. He also was a co-leader of a field trip for North Central GSA.

Janis D. Treworgy presented a paper entitled "Illinois Basin--A tectonically infuenced ramp during Chesterian time" to the Illinois Geological Society in September 1985, and the Indiana-Kentucky Geological Society in October 1985.

Robert C. Vaiden presented a paper co-authored by R. L. Langenheim, Jr. on "Biostratigraphy and paleoenvironment of Morrowan (Zone 20) Brachiopods, Bird Spring Group, Arrow Canyon, Clark County, Nevada" at the meetings of the American Association of Petroleum Geologists in New Orleans.

Robin Warren attended the annual meeting of the International Association of Engineering Geologists in Winston-Salem, NC in October 1985 and an International Workshop on Dam and Reservoir Failure at Purdue University in August 1985.

John R. Webster attended the Acid Rain Conference at Southern Illinois University-Carbondale in April 1985; the regional American Chemical Society meeting at Southern Illinois University-Carbondale in November 1985; and the meeting of the Northeast Section of the Geological Society of America in Kiamesha Lake, NY in March 1985. He presented a paper co-authored by R. H. Shiley, R. E. Hughes, P. L. Lapish, D. K. Cowin, G. V. Smith, C. C Hinckley, T. Nishizawa, N. Yoshida, T. Wiltowski, Y. Wada, and M. Saporoschenko, entitled "Desulfurization of Illinois coal by in-situ preparation of iron sulfide catalysts" at the Second Annual Pittsburgh Coal Conference held in Pittsburgh, PA in September 1985.

C. Pius Weibel attended the Midcontinent Meeting of the Society of Economic Paleontologists and Mineralogists held in Lawrence, KS in October 1985; the annual meetings of the Geological Society of America in Orlando, FL in October 1985; and two Illinois Geological Society meetings.

Teaching, Lectures, and Seminars

Richard C. Berg gave a talk on sandy soil pedogenesis to a University of Illinois soil geomorphology class.

Dwain J. Berggren planned and conducted a 6-hour field trip for the earth science teachers of Columbia Middle School in Champaign to demonstrate earth science concepts and teaching methods.

Charles Collinson is external Graduate Advisor to the Department of Geology, University of Illinois Chicago Circle. He also served as external advisor to the Department of Geology, University of Illinois, Champaign-Urbana. In addition, he presented a slide presentation and a field trip along the Lake Michigan shore to Zion West School on October 14.

B. Brandon Curry presentation to Math 436, Statistical Consulting, 3-13-86.

Leon R. Follmer serves as Collaborator with the College of Agriculture of the University of Illinois and as Adjunct Professor of Geology and Geography at the University of Illinois. He also presented seminars on various aspects of soils to the Geomorphology Group, the University of Illinois Geography Department's soil geomorphology class, the Geology Department's geomorphology class, and the Illinois Quaternary Association.

David L. Gross and John P. Kempton have presented numerous talks on the technical aspects of siting the Superconducting Super Collider in Illinois.

Paul C. Heigold lectured to undergraduate geology students at Southern Illinois University on "Seismicity in and around Illinois" in April 1985.

John P. Kempton presentations to Teachers' Institute-Rockford.

Dennis R. Kolata presented a talk on "Chemical Correlation on K-bentonite Beds in the Middle Ordovician Decorah Subgroup, Upper Mississippi Valley" to the Department of Geology at Northern Illinois University and a talk on "K-bentonites of the Ordovician Decorah Subgroup, Mississippi Valley: Correlation by Chemical Fingerprinting" to the Department of Geology at the University of Iowa, both in February 1986.

Jerry R. Miller presented a talk on sediment transport in fluvial systems at the Soils Geomorphology Seminar at the University of Illinois.

Rodney D. Norby served on the Final Examination Committee for Barry Wilson, a Master's degree student at Southern Illinois University in June, 1985. Several people at the Survey, particulary Bev Seyler, have assisted Mr. Wilson with this thesis work on the Aux Vases Sandstone in the subsurface of southern Illinois.

Lisa R. Smith made a presentation on maps to grade school children at Bottenfield School in Champaign, IL.

Christopher J. Stohr gave a talk on the geology of southern Illinois for a University of Illinois Department of Landscape Architecture field trip in the fall of 1985.

Poster Sessions and Educational Exhibits

Dennis D. Coleman presented an invited paper entitled Applications of geochemistry to the production, storage, and utilization of natural gas to the Association of Petroleum Geologists Annual Meeting, New Orleans, LA on March 24-27, 1985. He also presented a poster paper on "The use of stable isotope ratios for monitoring the behavior of organic and pyritic sulfur during desulfurization of Illinois coals" at the U.S. Geological Survey Symposium on Coal Quality held in Reston, VA in April 1985.

Joan C. Crockett presented a poster paper on "Petroleum Geology of Western Illinois" to the Kentucky Oil and Gas Association annual meetings in June 1985. She has also attended monthly Illinois Geological Society meetings, a log seminar held by Schlumberger, and a seismic seminar held by the Illinois Oil and Gas Association.

Jefferson Gilkeson presented a talk on the Water Use Act at a poster session during the July Association of Illinois Soil and Water Conservation Districts meeting in Springfield, IL.

B. Brandon Curry and Anne M. Graese presented a poster session co-authored with R. A. Bauer, R. C. Vaiden, W. G. Dixon, and W.-J. Su on "Engineering Characteristics of Bedrock for the Proposed Superconducting Super Collider in Illinois" at the annual meetings of the Geological Society of America in Orlando, FL in October 1985.

Jennifer K. Hines presented a poster paper co-authored by S. M. Miller, D. L. Gross, and E. D. McKay on "Environmental Screening/Siting the Superconducting Super Collider in Illinois" at the Geological Society of America national meetings in Orlando, FL in October 1985.

Nancy P. Holm attended the annual meetings of the American Society of Limnology and Oceanography and the International Association Great Lakes Research in June 1985, where she presented a poster session on her Lake Michigan Research.

Robert J. Krumm presented a poster paper entitled "An Extensive Geologic Data Base on a Geographic Information System" co-authored by E. D. McKay and J. R. Miller at the Geological Society of America annual meetings in Orlando, FL in October 1985.

Vickie L. Poole provided literature and counsel to Purdue University on stack-unit mapping and geology-for-planning techniques developed at the ISGS for a project entitled "Presentation of preliminary environmental geology reports for Medaryville, Winamac, and Bass Lake." This project was prepared for Arrowhead County Resource Conservation and Development Area by Purdue University graduate students and the presentations were attended by Vickie L. Poole, John P. Kempton, and Myrna M. Killey.

Phillip C. Reed, Ross D. Brower, and Edward Smith prepared and exhibited displays at the annual meetings of the Illinois Irrigation Association in Springfield and the Midwest Water Well Exposition in Rockford. During the technical program at the Exposition, Brower presented an illustrated presentation on the preparation of well plugging, health, and water well record forms.

David L. Reinertsen presented a talk about the Survey's educational services and displayed materials to Western Illinois University science teacher workshops at Macomb, Rock Island, and Springfield. He also presented displays on the Satellite Image Map, Potential for Contamination of Shallow Aquifers from Land Burial of Municipal Wastes Map, and educational materials for the Illinois Science Teachers Association annual meeting at Normal. In addition, he presented an introductory session on coal in Illinois to science teacher workshops in Quincy, Harper College, Prospect Heights, Rend Lake Community College, and Lincolnland Community College. He also presented displays on the western Illinois oil field near Colmar-Plymouth for the Illinois Oil and Gas Association at Robinson, IL.

Workshops/Training

Karen A. Albrecht presented a paper entitled "Sampling Strategy with Applied Geostatistics for ISGS Clay Liner" at the U.S. EPA On-Site Workshop on Field Permeability Measurement in Harrisburg, PA in December 1985. She also attened the ISIS Seminar on Supercomputers in Hydrology--Future Directions, in Lafayette, IN in September 1985.

Richard C. Berg contributed as a panel participant at an IEPA workshop in Rockford. He also was co-organizer of a meeting held in Winona, MN on the evolutionary history of the Upper Mississippi Valley.

Linda M. Bonnell attended the Black Shales Workshop in December 1985.

Susan Carol Bradford attended the University of Kentucky's short course, "Fundamentals of Geotechnical Engineering (Soil Mechanics) in March 1986.

J. James Eidel attended a DOE Organic Geochemistry Workshop in Norman, OK in January 1986.

Dr. Eidel served as General Chairman and Coordinator for the DOSECC sponsored Workshop on the Illinois Superdeep Drillhole that was held on the University of Illinois campus April 1-4, 1985. ISGS staff who served as co-chairman on a number of the committees, included: Robert Bauer, Rock Mechanics; James Bradbury, Ore Deposits; Keros Cartwright, Hydrology/Brine Geochemistry and the Environment; Paul Heigold, Geophysics; Dennis Kolata, Basin Analysis; John Nelson, Tectonics and Structure; Don Oltz, Hydrocarbon Studies; Neil Shimp, Geochemistry; and Steve Whitaker, Drill Hole Technology. Other ISGS participants in the workshop included Chen-Lin Chou, Heinz Damberger, Joyce Frost, Keith Hackley, Randy Hughes, Jack Liu, Bill Roy, Mike Sargent, and Janis Treworgy.

Bruce Hensel attended the Council of State Governments Ohio River Valley Workshops in January 1986.

Beverly L. Herzog presented "ISGS Studies of Field Permeability by Borehole Measurements" at a U.S. EPA Onsite Workshop of Field Permeability Measurement held in Harrisburg, PA in December 1985.

Latif Khan taught a mini-course on "Recovery of Coal from Abandoned Mine Lands and Effluents" during the 1985 Symposium on Surface Mining, Hydrology, Sedimentation and Reclamation at Lexington, KY.

Ardith K. Hansel, Myrna M. Killey, and Robert J. Krumm attended an SEPM short course on "Glacial Sedimentary Environments" held in De Kalb, IL in April 1985.

Morris W. Leighton delivered a welcoming address to the Workshop on the Illinois Basin Superdeep Drillhole on April 2, 1986. He also served as Recorder for the Geology, Seismology, and Parallel Discipline Workshops sponsored by the Central United States Earthquake Consortium and State Emergency Disaster Agencies in Nashville, Tennessee.

E. Donald McKay III has held workshops on the Geographic Information System for geoscientists from the Tennessee, Missouri, and Pennsylvania Geological Surveys.

Vickie L. Poole contributed to two Ohio River Valley Groundwater Workshops, one on technical issues held at Ft. Mitchell, KY in January 1986, the other on policy issues held at Louisville, KY in February 1986.

David L. Reinertsen attended a TV workshop presented by Urbana Cablevision.

J. Bruno Risatti was an invited participant at the Cretaceous Black Shales, Joint Oceanographic Institutes/U.S. Science Advisory Committee Workshop in Denver, CO, and the Continental Drilling Program-Organic Geochemistry Workshop in Norman, OK.

Public Addresses

Richard C. Berg gave a talk on geology of wetland sites at a meeting of principal investigators for a project in Lisle, IL.

Charles Collinson presented a public lecture on the "State of the Lake" at Great lakes Officer's Club sponsored by the American Society of Military Engineers on January 15.

Charles Collinson presented a lecture "Lake Levels and Shore Erosion" to the Governor's Conference on Lake Michigan, Illinois Great Lake in September. The lecture will be published in the meeting's proceedings in 1986.

J. James Eidel gave talks on the Illinois Superdeep Drillhole at the Illinois Geological Society, the University of Illinois at Champaign-Urbana, Southern Illinois University-Carbondale, and Argonne Laboratory.

John M. Fox presented a talk to the Prairie Gem and Geological Society of Urbana entitled "Carbonate Environment and Reefs of the Exuma Islands, Bahamas."

Mark Grubb presented a talk on "Geomorphology in the Large River LTER Site" at the Louisiana Center for Wetlands Research at Louisiana State University.

Jennifer K. Hines presented two talks on landslides to students at Columbia Middle School in Champaign.

Myrna M. Killey presented a talk on earthquake awareness, the probable reponse of Quaternary sediments in southern Illinois to a severe earthquake, and their probable effect on lifeline services at a seminar for emergency service personnel and the public at a seminar sponsored by the Carbondale Emergency Services and Disaster Agency at SIU-Carbondale. She also gave a slide-illustrated talk on Champaign County glacial history to the Champaign County Historical Society in May 1985.

Morris W. Leighton presented a talk on "The Illinois State Geological Survey--Finding Solutions to Illinois' Economic and Environmental Problems" at the University of Illinois Foundation's Illinois Network Event and "An Evening for Illinois," in Salem on November 18, 1985. He also talked before the Ambassadors Club in Urbana on "Two Examples of ISGS Efforts In Working Toward a Healthy Economy" on May 1, 1985.

David L. Reinertsen presented a talk about the Sandwich Fault Zone to a group of Reitred State employees at Joliet. He gave a talk about the Survey to the Pana Rotary Club and talks about geology, rocks, and minerals to three grade school classes in Champaign.

Christopher J. Stohr gave talks on the Satellite Image Map of Illinois to C-U Toastmasters Urbana; Channel WICD, Champaign; and a Univeristy of Illinois journalism class.

Radio, TV, Press Interviews/Presentations

Richard C. Berg and Walter J. Morse were interviewed by a television news crew from Rockford, Illinois, in July, 1985. They discussed aspects of potential groundwater contamination from the disposal of sewage sludge on farm land based on a Survey study near Rockton, Illinois.

Heinz H. Damberger worked with the "Prairie Pathways" staff at WILL-TV to produce a 10-minute feature on the cooperative geologic mapping program (COGEOMAP) of southern Ilinois. Several ISGS staff members were interviewed both in the field and at the Survey; those appearing in the program included Dennis D. Coleman, Joseph A. Devera, Leon R. Follmer, Richard D. Harvey, Russell J. Jacobson, Donald K. Lumm, W. John Nelson, Russel A. Peppers, Matthew Riggs (SIU), C. Brian Trask, and Colin G. Treworgy.

Barry Fisher has appeared on programs of WILL-TV and University of Illinois TV explaining the ISGS radioacarbon dating laboratory.

J. James Eidel and Jonathan H. Goodwin provided several radio interviews for news programs about the Illinois Superdeep Drillhole Proposal in April 1985.

Paul C. Heigold did interviews with WGN Chicago Radio News and with WILL Urbana Radio regarding "Earthquakes in Illinois". He also also answered many requests for information on a wide range of geophysical data, gravity and magnetic fields in Illinois, and seismic risk from natural earthquakes and man-made vibrations from industry, state and federal agencies, educational institutions, the press, radio, TV, and the general public.

Morris W. Leighton and James Eidel participated in a press conference on the Illinois Superdeep Drillhole on April 2, 1985.

Donald G. Mikulic was interviewed by Channel 2, CBS, Chicago concerning Silurian reefs and oil in Lake Michigan.

C. Brian Trask made several contacts with the press concerning the COGEOMAP program; these included the Evansville, IN Courier, WSIL-TV in Harrisburg, IL, the Southern Illinoian Newspaper at Carbondale, IL, and WILL-TV, Urbana.

Governmental Committees

Robert A. Bauer gave counsel and advice to the Illinois Department of Mines and Minerals for Office of surface Mining permits to mine coal.

Richard C. Berg represented the Survey on the Inter-agency Task Force for groundwater protection.

Charles Collinson was official representative of the Department of Energy and Natural Resources at the semi-annual meetings of the U.S. Great Lakes Commission which held meetings in Indianapolis (September, 1985) and Washington, DC (March, 1986). He also represented the Department at the International Joint Commission (Canada-U.S.) meetings in Kingston, Ontario (June, 1985). He represented the Scientific Surveys in the lengthy preparation of recommendations for the Governor's Natural Resources Cabinet Initiative for Lake Michigan Programs. In September Governor Thompson requested such recommendations. Collinson represented the surveys in presentations to the Governor's staff.

Leon R. Follmer is a member of the University of Illinois College of Agriculture's Committee on Reclamation of Mined Land and Mine Refuse.

Dennis P. McKenna serves as advisor to Rockford-Winnebago County Solid Waste Intergovernmental Committee.

Governmental Testimony/Presentations

Richard C. Berg, Thomas M. Johnson, Robert G. Griffin, and William R. Roy provided testimony to the Illinois Pollution Control Board on November 16-17, 1985, concerning siting and site characterization of solid waste disposal facilities.

Richard C. Berg and Vickie L. Poole provided counsel to Champaign-Urbana and Champaign County officials on the hydrogeology of Champaign County with regard to siting a new landfill.

Richard C. Berg and Dennis P. McKenna advised the Winnebago county Solid Waste Task Force on landfill siting.

Richard C. Berg, Myrna M. Killey, and Dennis P. McKenna met with Champaign County Planning Staff regarding geology for planning and waste disposal.

Dwain J. Berggren, L. Iverson, and K. Grunwald, at the request of the Illinois Abandoned Mined Lands Reclamation Council, examined the reclaimed historic longwall mine sites in Putnam and Bureau Counties to determine why spring seedings of cover vegetation had failed.

Susan Carol Bradford provided geotechnical site evaluations for 9 factory sites proposed by the Department of Commerce and Community Affairs. She also did geotechnical site evaluations of landslides requested by township trustees for the city of Watseka, Iroquiois County.

Ross D. Brower is sceintific advisor to the Class I program within the Division of Land Pollution Control, IEPA. He is also advisor to the State Water Survey on hydrogeological aspects of municipal groundwater supplies. In addition, he provided counsel to Region V, U.S. EPA on UIC activities in Illinois and Indiana.

Keros Cartwright provided assistance and advice to the Illinois Environmental Protection Agency on problems relating to waste disposal, the Illinois Department of Nuclear Safety on radioactive waste disposal and the U.S. EPA in problems encountered at Superfund sites. He also served on the U.S. EPA Science Advisory Board subcommittees on groundwater research and grundwater monitoring. He is a member of the Groundwater Task Force of the Illinois Water Plan, the Great Lakes Commission Groundwater Committee, and of three Ph.D. Committees at the University of Illinois.

Dennis D. Coleman serves as an advisor to the National Science Council of the Republic of China (Taiwan).

Charles Collinson provided extensive counsel and advice on Lake Michigan problems to state, regional, and local government bodies, citizen groups, and consultants. Clients include Illinois Capital Development Board, Illinois Department of Conservation, Illinois Division of Water Resources, U.S. Army Corps of Engineers, Chicago Park District, Lake County Department of Planning, Zoning and Environmental Quality, City of Evanston, Village of Wilmetter, Village of Glencoe, City of Lake Forest, Waukegan Port Authority, A. Epstein & sons, Charles Shabica Associates, CENCOM, Inc., and Moffatt & Nicol Engineers.

Heinz H. Damberger provided geologic information to the Southwestern Illinois Economic Development Study of DCCA. He also provided advice and support for ENR staff for coal development activities such as siting information for coal conversion plants. He is ISGS correspondent to the bi-monthly Illinois Energy Newsletter.

Paul B. DuMontelle, Myrna M. Killey, and Robert J. Krumm consulted with Randolph County Emergency Services and Disaster Agency personnel on landslide problems in the Chester, IL area.

Leon R. Follers advises the Soil Conservation Service on soil survey issues and provided liaison at the SCS Annual Planning Conference by explaining ISGS activities. He has also participated in SCS soil survey reviews in Livingston, Vermilion, Jasper, McLean, Pike, and Marion Counties.

John M. Fox conferred with a N.A.S.A. representative regarding the possibilities and potential difficulties in building ceramic structures and roads in Illinois; provided Morton Arboretum with results from mineralogical analyses done on a wetland study in northern Illinois; and provided rock identifications and discussed possible sources and ways of categorizing stone artifacts from archaeological sites for the University of Illinois Archaeology Department.

Robert H. Gilkeson presented a talk entitled "Exploration for Shallow Groundwater Resources in Kane County" to the Kane Cunty Government and "Geologic Mapping as a Method for Land Use Planning and Groundwater Protection" to the Fox Valley Water Commission. In addition, he gave a talk on "Groundwater Activities of the Illinois Geological Survey" to the Illinois Groundwater Association at its spring meeting. He also provided counsel and advice to the Fox Valley Water Commission on shallow groundwater resources and on radium in groundwater from the Cambrian and ordovician bedrock.

Herbert D. Glass provided clay mineral analyses for more than a dozen Federal, State, and Survey projects.

Paul C. Heigold provided service to the Illinois Emergency Services and Disaster Agency regarding earthquake preparedness, to the Federal Emergency Management Agency regarding earthquake education programs, and to the Illinois Bureau of the Budget regarding earthquake information dissemination.

Bruce Hensel provided counsel to the Attorney General's Office regarding the Kerr-McGee site in West Chicago.

Beverly L. Herzog provided expert witness testimony in a landfill case for the Attorney General's office. In addition, she prepared approximately 10 landfill reports for the Illinois EPA and assisted the IEPA and the Attorney General's office with information.

Nancy P. Holm provided information on Lake Michigan current projects and publications to such agencies as the Great Lakes Commission, University of Wisconsin Sea Grant IL/IN Sea Grant, consultants for U.S. EPA, U.S. Fish and Wildlife Service, and League of Women Voters. She also assisted the Great Lakes Program at SUNY at Buffalo in planning a computerized database on Lake Ontario and Lake Erie.

John P. Kempton and Vickie L. Poole provided information on groundwater resources for the City of Normal in conjunction with siting the Chrysler-Mitsubishi plant.

Dennis R. Kolata serves as a consultant to the U.S. Geological Survey regarding lower Paleozoic echinoderm faunas from the Virginia Piedmont.

Douglas E. Laymon provided counsel to the USGS Water Resources Division, Urbana, on microseismic surveying in Cook County Forest Preserve.

Morris W. Leighton serves as a member of the Program Committee, Center for Research on Sulfur in Coal. He also serves as a member of the Illinois Emergency Services and Disaster Agency's Earthquake Advisory Board which authored a report on "Action Plans for Illinois Earthquake Preparedness," January 1986.

John M. Masters assisted the Geologic Engineering Section, U.S. Army Corps of Engineers, Louisville, KY in the identification and correlation of drilling samples taken near Olmsted, IL. In addition, he and Philip C. Reed provided geologic counsel to the Chief of the Geotechnical Design Section, U.S. Army Corps of Engineers, Memphis, TN on the identification and distribution of valley fill materials along the Ohio River levee near Mounds City, IL.

Dennis P. McKenna serves as a panel member at two IEPA public meetings on Groundwater Protection Plan. He also represented the Survey at a meeting of Soil and Water Conservation Districts in southeastern Illinois to discuss oil field brine issues. He was Survey representative at a legislative meeting and reviewed policy statements of the Association of the Illinois Soil and Water Conservation Districts on groundwater withdrawal issues.

Edward Mehnert met with the Department of Health of IEPA and a project consultant concerning groundwater contamination at Lisbon, IL. He also assisted in a drilling project at Kerr-McGee's West Chicago site for the State Attorney General's office in August 1985.

Jerry R. Miller provided counsel to Argonne National Laboratory in their search for a suitable disposal site for low-level radioactive wastes. He also provided counsel to the Attorney General's office with field descriptions of samples collected during drilling operations at the Kerr-McGee hazardous waste site.

Michael V. Miller consulted with the Illinois Department of Conservation on the Lower Cache River and the Big Muddy River cutoff in May 1985.

Kerry M. Riley did pipeline gas analyses for the Illinois Commerce Commission.

David L. Reinertsen represents the Director of the Department of Energy and Natural Resources on the Statewide Advisory Board for Conservation Education and the Illinois State Board of Education.

William R. Roy provided testimony as an expert witness for hearings by the Illinois Pollution Control Board on permit requirements for owners and operators of Class I and Class II landfills in November 1985. He also assisted in the assessment of the migration of acid from a spill at the Abbott Power Plant, University of Illinois, Champaign.

Edward C. Smith wrote a report on geologic conditions in the area of the Joliet Army Ammunition Plant for an Argonne National Laboratory environmental assessment. He also co-authored part of a report on groundwater conditions in southwestern Illinois furnished to the Governor's office.

Lisa R. Smith provided assistance to the Illinois Department of Conservation with an updated survey of the shoreline at Illinois Beach State Park, providing estimates of shoreline losses. This reach is losing more than an acre per month. She participates in regular Lake Michigan shore reconnaissance for IDOC. She also assisted in preparation of a report concerning the deteriorating breakwater at Waukegan.

Service on Industrial Committees

Philip J. DeMaris provided assistance to Freeman Coal Mine Company, Crown II Mine in mapping their strike-slip fault zone in a new section of the mine.

Leon R. Follmer advised a geological consultant concerning landfill expansion near Edwardsville and visited a Caterpiller test site near Peoria to assess potential for gravel resources.

Ivan G. Krapac advised the Chemical Manufacturers Association regarding deep well injectioin in Illinois. He also advised the IEPA about a statistical sampling protocol to monitor deep well injection wastes.

Morris W. Leighton is serving as Editor, Interior Cratonic Sag Basin Volume, AAPG Petroleum Basin Series.

William R. Roy met with Velsicol representatives on deep well injection in February 1986.

Michael L. Sargent provided information about drift thickness and bedrock geology at Hersher, IL to Natural Gas Pipeline, Storage Division. He also interpreted the subsurface geology along the Illinois River between Bureau and Putnam Counties for Consolidated Grain and Barge Company.

Public Service

Susan Carol Bradford served as judge for the 1985 Illinois Junior Academy of Science state competition held in Champaign.

Charles Collinson and Lisa Smith are providing scientific expertise and materials to the Illinois Danesland Preservation Association, which is preparing displays and activities for Illinois Beach State Park.

Joseph A. Devera donated 5 vacation days to exploration for dinosaur bones and unearthing a Camarasaurus for Dinosaur National Monument.

Paul B. DuMontelle presented a paper entitled "Illinois Mine Subsidence Research Program: Coal and Crops Working Together," co-authored by Robert A. Bauer, to the Conference on Ground Control at Carbondale and to the Illinois Mining Institute in Springfield.

David L. Gross served as the Co-Chair of the 1985 United Way Campaign at the University of Illinois. That drive raised $377,000 which is 26% of the total budget of the United Way of Champaign County. He has been named Chair of the 1986 United Way Campaign. He was member of the Board and the President-Elect of the Urbana Rotary Club.

Latif Khan provided counsel to the Muslim Students Association at the University of Illinois and serves as Vice President of the Afghanistan Freedom Fund Committee.

Lawrence B. Kohlenberger is adviser to Abbott Power Plant engineers on the types of analyses needed after conversion to their new coal scrubber facilities.

Morris W. Leighton is a member of the Library Friends Advisory Board, University of Illinois. He also served as Chairman, Institutional Advisory Board, Center for Research on Sulfur in Coal.

Chao-Li Liu was invited to participate in the IAEA/COFRC Natural Gas Isotope Standards Inter-laboratory comparison.

John M. Masters is Judging Chairman, Earth Science Division, Illinois Junior Academy of Science Annual Exposition at Champaign, IL. Philip C. Reed and Jonathan H. Goodwin serve as co-chairs with him.

Rodney D. Norby has provided Dr. L.W. D. Bridges of Denver, Colorado, with identifications and geothermal indices for some conodonts from the Mississippian Leadville Limestone of Colorado. The relative age dates and geothermal indices are important in determining whether solution features at the top of the Leadville are due to Tertiary subsurface solution or to Paleozoic Karst.

David L. Reinertsen is merit badge counselor for Boy Scout Troop 7 and Explorer Post 7, Champaign.

Massoud Rostam-Abadi serves on the International Student Center Committee at the University of Illinois.

ACTIVITY MEASURES

Background

All Illinois state agencies are required to provide activity measures as part of their annual budget presentations to the legislature. Selected activity measures also are included in the Governor's report, Illinois State Budget. Internally, we use a wide range of activity measures to gauge how effective we are at reaching the public with our information and services. The measures are also helpful indicators of where our research and service staff are applying their greatest energies and to what degree we may need to adjust or re-shape our program, budget or organization.

Although records are kept throughout the year on such items as publications issued or numbers of sponsored research projects, many of our activity measures are based on annualized calculations from samples counted during a representative one- or two-month time period. In most cases, this limited sampling provides a sufficient level of accuracy. However, this has been an extraordinary year. Such measures as numbers of telephone calls and pieces of mail commonly are counted during January and February each year. During December and January, the Information and Technical Services Unit was deluged with telephone and mail orders for the newly released Satellite Image Map of Illinois. The first 5,000 copies were ordered or purchased over the counter in our Information Office in just 5 days from December 2 to December 6. Almost the entire double press run--14,000 out of 15,000 copies printed--was distributed over the 60 days from December 2 to January 31. The extraordinary demands placed on the Information and Technical Services Unit made the normal counting period impractical. Our estimates this year, therefore, are based on only a 3- to 4-week counting period during February and are not really representative of the total numbers of persons who have used the services of the Geological Survey this year.

Measures

Research Activities. The ISGS had 136 state-funded projects in progress during the year. Of these, 28 were in the area of Environmental Geology, 62 in the area of Mineral Resources studies, and 46 in the area of General and Basic Research. This ratio reflects the significant contract and grant support that is available in the area of Environmental Geology. Of the 92 sponsored research projects active during the year, 43 were in the area of Environmental Geology, 34 in Mineral Resources, and 15 in General and Basic Research. The sponsored research projects constitute about 40 percent of the total number of active projects. However, the count of research projects is compiled from the list of active University of Illinois Research Accounts. Since some projects may receive multiple awards during the year, this counting method overemphasizes somewhat the number of sponsored research projects.

To present our research information to the public and the scientific community, we published 189 new reports, abstracts and maps. The Information and Technical Services Unit distributed 28,258 copies of ISGS publications, 21,087 copies of ISGS maps and 16,830 U.S. Geological Survey map products. The total of 49,345 copies of ISGS publications distributed is 55 percent greater than last year's total. We distributed 13.8 percent more reports, 201 percent more ISGS maps, and 12.6 percent more U.S. Geological Survey map products than last year. The increase in ISGS maps distributed is largely attributable to the extraordinary demand for the Satellite Image Map of Illinois. The increased demand for U.S. Geological Survey map products was generated both by the availability of more 7.5-minute topographic quadrangles maps, and by requests related to orders for the Satellite Image Map of Illinois.

It should be noted that the figures for "publications distributed" in this section of last year's annual report (1984-85) did not include items distributed gratis in bulk mailings. The percentage increases for this year, however, are based on updated values for 1984-85 that include these free distributions to libraries and others on our mailing lists. Last year we sent out 17,778 free ISGS publications in bulk mailings in addition to the 17,768 items that were sold or consumed internally. This year we provided free distribution for 20,945 copies of ISGS reports and maps.

Public, Government, and Industry Services. The accompanying table shows selected measures of our services provided during the year, distributed by program areas.

- Information Responses: We responded to inquiries from 9,627 visitors, 5,175 letters, and 9,420 telephone calls. The Geological Records Unit (GRU) alone served 2,921 visitors, received 3,154 phone calls and 441 letters, and handled 88,986 files. Despite the decline in oil prices, the number of files handled by GRU increased by almost 18 percent, and the number of phone calls by 36 percent. Because the sharpest oil price decline occurred near the end of the reporting year, the year's statistics do not fully reflect the decline in activity observed by the GRU staff beginning in November. The Geological Samples Library distributed 630 sample sets to 189 visitors for examination and study, and 509 sets for study by ISGS staff members.

- Identification, Analyses, and Reports/Memos: ISGS scientists completed 33,711 technical analyses and prepared 1,684 unpublished reports, letters and memos to present the results of those analyses. Both these numbers are twice as great as last year and their magnitude emphasizes the increased demands from the public, industry, and government for the analytical and technical services available at ISGS. Such testing adds to the overall data base of the Survey, but is costly in terms of both staff time and material resources. Tests performed for both research and service purposes include X-ray diffraction and

The ISGS/USGS COGEOMAP project was featured on central Illinois' PBS station. The WILL camera focuses on Leon R. Follmer, Stratigraphy and Surficial Geology Section, who points out the quadrangles being mapped cooperatively with the U.S. Geological Survey and indicates the southernmost limit of the glacial margin in Illinois.

ISGS display at the Coal Exposition held in March 1986 at Southeastern Illinois College in Harrisburg. Stephen K. Danner, Geologist in Coal Section, answered questions and distributed information.

fluorescence analyses; rock strength tests; particle size analyses; radiocarbon dating; major, minor and trace element chemical analyses; and proximate and ultimate analyses of coal. Our scientists also conducted 38 electrical earth resistivity surveys, completed stratigraphic logs of 33 drillholes and geophysical logs of 28; prepared 98 groundwater reports; 30 waste disposal reports; 68 high volume well reports and 3 deep well disposal reports. In the Computer Research and Services Section, ISGS staff wrote 150 programs; digitized 25 maps; encoded, entered and verified data for 50 different projects, and prepared 385 computer-plotted maps primarily for internal use. In the pilot study of mineralization in insoluble residues, our mineral resource scientists split 2,697 old insoluble residue samples for spectrographic analysis and split and dissolved 1,425 new samples. Scientists from the U.S. Geological Survey analyzed 1,663 samples during a 3-week visit by the Survey's mobile analytical laboratory.

Continuing Scientific/Educational Contributions. Geological Survey staff members presented 178 papers and poster sessions at various learned and professional society meetings, and participated 80 times in various field trips and conferences. We also presented 53 lectures, seminars and classes for schools and other educational groups, and participated in or led 55 workshops or training courses. Staff members held 70 offices or committee memberships in professional and educational organizations, reviewed 218 outside manuscripts and abstracts for journals, and provided formal and informal guidance for 65 graduate students. Our scientists held 588 office conferences with visitors to exchange scientific and technical information. The Educational Extension Unit distributed 138 rock and mineral sets, 18 partial sets and 50 coal balls to Illinois schools. They also distributed 235 copies of Educational Series publications, 110 copies of the topographic mapping exercise, and more than 500 copies of the field trip guide leaflets.

Public, Industry, Government Contributions. Survey staff members presented 50 public addresses, gave 55 talks or interviews for the press, presented testimony at 5 government hearings and expert testimony in 2 judicial proceedings, and appeared 40 times to serve on or provide information for various governmental, industrial, and public committees and other agencies. These all are included in the 330 talks and presentations summarized in the following table.

Illinois State Geological Survey Selected Activity Measures 1985-86

	Mineral Resources	Environmental Geology	General and Basic Research	Administrative Services	Total
Reports/Maps Published (Distributed)	83	76	26	4	189 (49,345)
Unpublished Reports, Memos, and Other Responses	821	408	455	0	1,684
Lectures, Talks, and Presentations	129	185	76	20	410
Workshops, Classes, and Seminars	38	30	30	0	98
Visitors and Office Conferences	4,508	917	497	3,705	9,627
Telephone Inquiries	5,373	2,059	343	1,645	9,420
Letter Inquiries	1,122	531	78	3,444	5,175